atlantic

Aerial LiDAR Report

13-165

Mobile County LiDAR

November 25th, 2015

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Name of Job:	Mobile County LiDAR
Job No:	13165
Period of Performance:	01/12/2014 – 11/25/2014

Atlantic was contracted to acquire high resolution LiDAR (Light Detection and Ranging) data located in Mobile County, Alabama. The intent was to collect one (1) Area of Interest (AOI) that encompasses Mobile County. The total client defined AOI was 1,402 square miles or 3,361 square kilometers.

Successful completion of the project required accurate and reliable capture of airborne LiDAR and flight line calibration.

Project Area

Atlantic collected and processed topographic airborne LiDAR for the client defined AOI of 1,402 square miles in West Alabama.

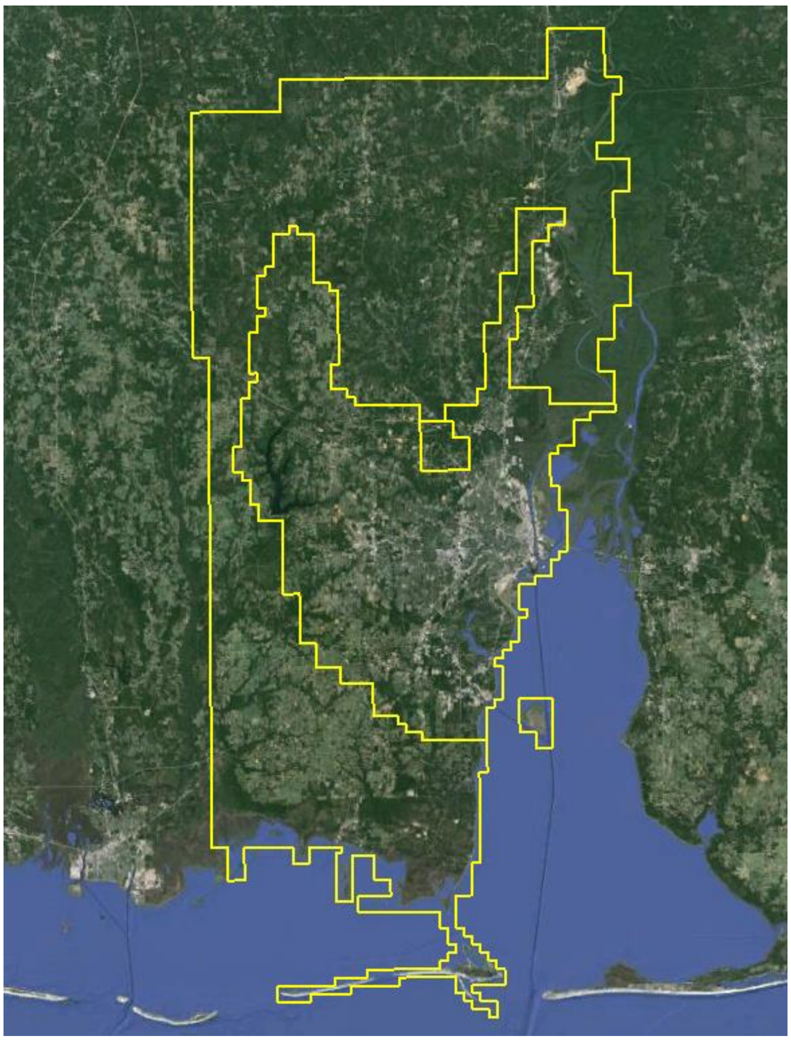

Figure 1: Project Area

Reference System

Horizontal Datum:	North American Datum of 1983
Coordinate System:	State Plane Alabama West Zone (FIPS 0102)
Vertical Datum:	North American Vertical Datum of 1988
Geoid Model:	Geoid12A
Units:	U.S. Survey Feet

LiDAR Acquisition Details

Atlantic acquired 74 passes of the AOI as a series of sequential and perpendicular flight lines. The flight plan included zigzag flight line collection as a result of the inherent IMU drift associated with all IMU systems. In order to reduce any margin for error in the flight plan, Atlantic followed FEMA's Appendix A "guidelines" for flight planning which, at a minimum, included the following criteria:

- A digital flight line layout using LEICA MISSION PRO flight design software for direct integration into the aircraft flight navigation system.
- LiDAR coverage extended by a predetermined margin beyond all project borders to ensure necessary over-edge coverage appropriate for specific task order deliverables.
- Local restrictions related to air space and any controlled areas were investigated so that required permissions could be obtained in a timely manner with respect to schedule.
- File all flight plans as required by local Air Traffic Control (ATC) prior to each mission.

Atlantic monitored weather and atmospheric conditions and conducted LiDAR missions only when conditions existed that would not degrade sensor ability in the collection of data. These conditions included no snow, rain, fog, smoke, mist and/or low clouds. LiDAR systems are active sensors, not requiring light, thus missions may be conducted during night hours when weather restrictions do not prevent collection. Atlantic accessed reliable weather sites and indicators (webcams) to establish the highest probability for successful collection in order to position our sensor to maximize successful data acquisition.

Within 72-hours prior to the planned day(s) of acquisition, Atlantic closely monitored the weather, checking all sources for forecasts at least twice daily. As soon as weather conditions were conducive to acquisition, our aircraft mobilized to the project site to begin data collection. Once on site, the acquisition team took responsibility for weather analysis. Atlantic LiDAR sensors are calibrated at a designated site located at the Fayetteville Municipal Airport (FYM) in Fayetteville, TN and are periodically checked and adjusted to minimize corrections at project sites.

Acquisition Equipment

Atlantic operated a Partenavia S.P.A. P 68 C/TC (N775MW) outfitted with a Leica ALS70-HP LiDAR system during the collection of the project area. **Table 1** represents a list of the features and characteristics for the Leica ALS70-HP LiDAR system:

Atlantic's Sensor Characteristics		
Leica ALS70-HP		
Manufacturer	Leica	
Model	ALS70 - HP	
Platform	Fixed-wing	
Scan Pattern	sine, triangle, raster	
Maximum Scan rate (Hz)	sine	200
	triangle	158
	raster	120
Field of view (°)	0 - 75 (full angle, user adjustable)	
Maximum Pulse rate (kHz)	500	
Maximum Flying height (m AGL)	3500	
Number of returns	unlimited	
Number of intensity measurements	3 (first, second, third)	
Roll stabilization (automatic adaptive, °)	75 - active FOV	
Storage media	removable 500 GB SSD	
Storage capacity (hours @ max pulse rate)	6	
size (cm)	Scanner	37 W x 68 L x 26 H
	Control	45 W x 47 D x 36 H
Weight (kg)	Scanner	43
	Control	45
Operating Temperature	0 - 40 °C	
Flight Management	FCMS	
Power Consumption	927 @ 22.0 - 30.3 VDC	

Table 1: Atlantic's Sensor Characteristics

LiDAR System Parameters

Table 2 illustrates Atlantic's system parameters for LiDAR acquisition on this project.

LiDAR System Acquisition Parameters	
Item	**Parameter**
System	Leica ALS-70 HP
Altitude (AGL meters)	2350
Approx. Ground Speed (kts)	120
Laser Firing Rate (kHz)	231.2
Scan Frequency (hz)	53.4
Swath width (m)	1710
Swath Overlap (%)	30
Line Spacing (m)	1129
Pass heading (degree)	180
Field of View (degree)	40
Points per meter^2 (m)	2
Scan Pattern	Triangle

Table 2: LiDAR System Acquisition Parameters

LiDAR Acquisition Control

One (1) NGS monument was used to control the LiDAR acquisition for the project area. The coordinates are provided in Table 3 below in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

Acquisition Control Coordinates				
Name	**PID**	**Latitude (N)**	**Longitude (W)**	**Height**
MOB_AP_STA_A1	AA8546	30°40'50.96007"	088°14'12.44564"	35.434

Table 3: Acquisition Control Coordinates

Acquisition Status Report and Flightlines

Upon notification to proceed, the flight crew loaded the flight plans and validated the flight parameters. The Acquisition Manager contacted air traffic control and coordinated flight pattern requirements. LiDAR acquisition began immediately upon notification that control base stations were in place. During flight operations, the flight crew monitored weather and atmospheric conditions. LiDAR missions were flown only when no condition existed below the sensor that would affect the collection of data. The pilot constantly monitored the aircraft course, position, pitch, roll, and yaw of the aircraft. The sensor operator monitored the sensor, the status of PDOPs, and performed the first Q/C review during acquisition. The flight crew constantly reviewed weather and cloud locations. Any flight lines impacted by unfavorable conditions were marked as invalid and re-flown immediately or at an optimal time.

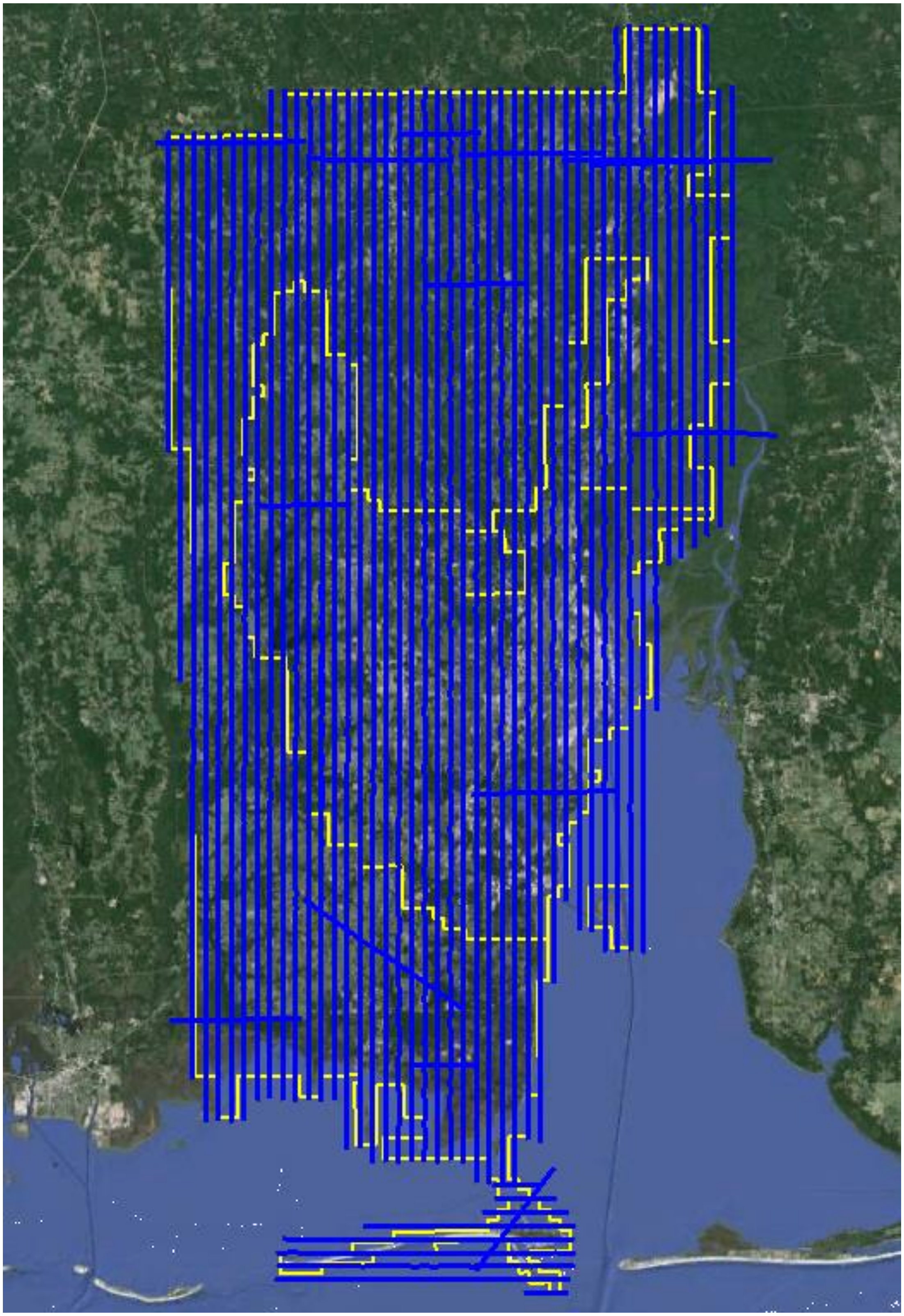

Figure 2: Trajectories as flown by Atlantic

Airborne GPS Kinematic

Airborne GPS data was processed using the Inertial Explorer (version 8.5.4320) software. Flights were flown with a minimum of 6 satellites in view (12° above the horizon) and with a PDOP of less than 3 during laser scans. Distances from base station to aircraft were kept to a maximum of 32km.

For all flights, the GPS data can be classified as good, with GPS residuals of 3cm average or better but none larger than 10cm being recorded.

Data collected by the LiDAR unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

GPS processing reports for each mission are included in **Appendix A**.

Generation and Calibration of Laser Points

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete. Subsequently, the mission points are output using Leica's ALS Post Processor initially the most recent boresight values. The initial point generation for each mission calibration is verified within TerraScan using distance colored points to identify errors. If a calibration error greater than specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. Once validated each output mission is imported into the GeoCue software package. Here a project level supplementary coverage check is carried out to ensure no data voids unreported by Field Operations are present.

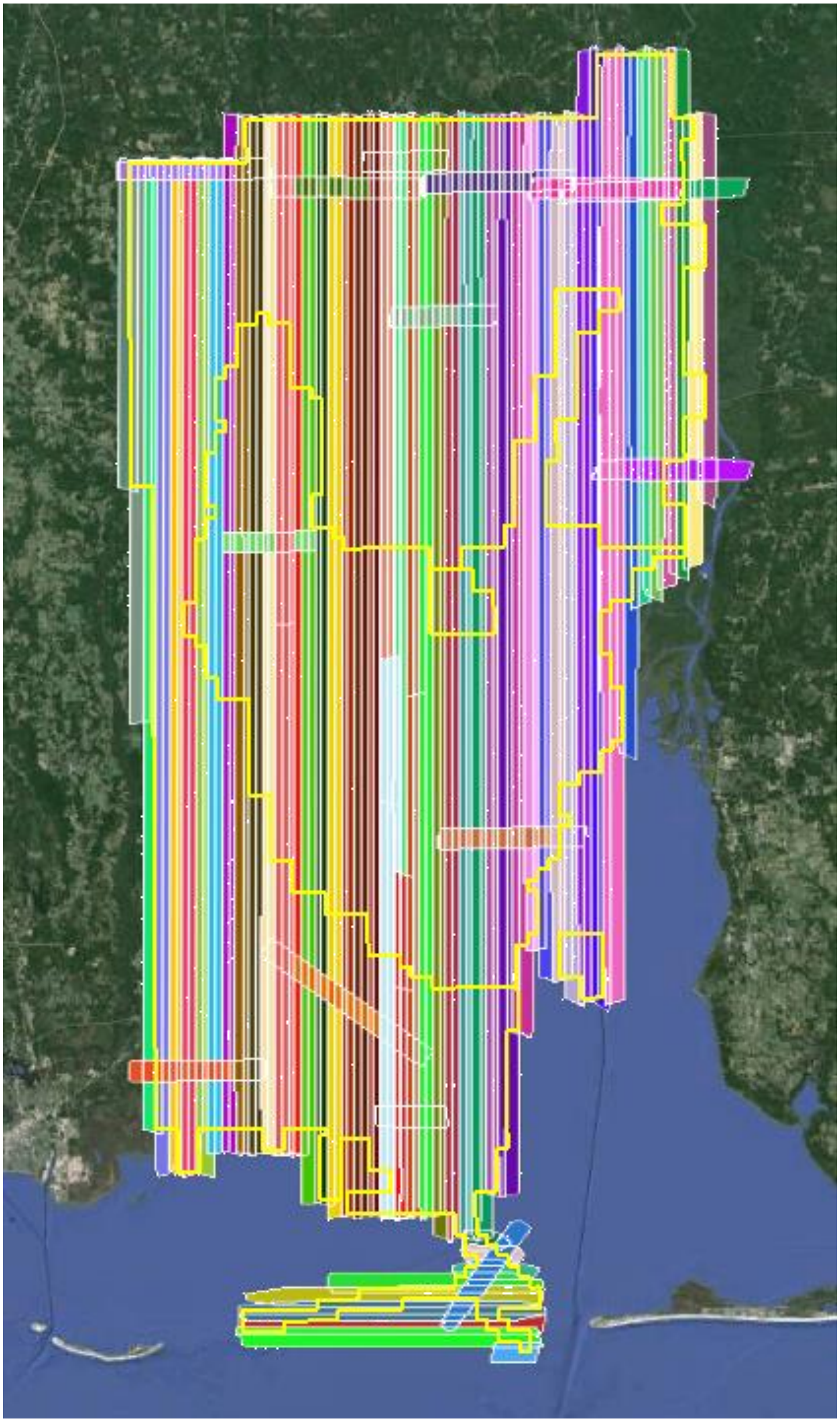

Figure 3: LiDAR swath data showing complete coverage

Relative Accuracy

For effective data management, each imported mission is tiled out in GeoCue to a project specific tile scheme or index. Relative accuracy and internal quality are then checked using a number of carefully selected tiles in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed by the generation of Z-Difference colored intensity orthos in GeoCue. The color scale of these orthos are adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flight line to flight line and mission to mission alignment. When available, surveyed control points are used to supplement and verify the calibration of the data.

Accuracy Results

An overall statistical assessment of the LiDAR checkpoints in feet can be found in **Table 4**, **5**, **6** and **7**.

Fundamental Vertical Accuracy of the LiDAR Point Data		
Land Cover Category	**# of Points**	**FVA — Fundamental Vertical Accuracy (RMSEz x 1.9600) Spec=.60ft**
Open Terrain	23	0.511

Table 4: Fundamental Vertical Accuracy of the LiDAR Point Data

Checkpoint Vertical Accuracy								
100 % of Totals	**RMSE (ft)**	**Mean (ft)**	**Median (ft)**	**Skew**	**Std Dev (ft)**	**# of Points**	**Min (ft)**	**Max (ft)**
Consolidated	0.402	-0.118	-0.095	-0.127	0.386	111	-0.993	0.969
Open Terrain	0.261	0.018	-0.040	0.321	0.266	23	-0.357	0.480
Urban	0.268	0.075	0.110	-0.550	0.263	26	-0.506	0.550
High Grass	0.474	-0.178	-0.255	0.791	0.450	21	-0.993	0.969
Trees	0.462	-0.338	-0.345	0.295	0.322	21	-0.795	0.291
Low Trees	0.516	-0.214	-0.242	0.200	0.332	20	-0.926	0.465

Table 5: Control Point Vertical Accuracy

Vertical Accuracy Assessment				
Land Cover Category	**# of Points**	**FVA — Fundamental Vertical Accuracy (RMSEz x 1.9600)**	**CVA — Consolidated Vertical Accuracy (95th Percentile)**	**SVA — Supplemental Vertical Accuracy (95th Percentile)**
Consolidated	111		0.457	
Open Terrain	23	0.511		
Urban	26			0.408
High Grass	21			0.563
Low Trees	21			0.121
Trees	20			0.394

Table 6: Vertical Accuracy Assessment

LiDAR Checkpoints							
PointID	**Easting**	**Northing**	**Elevation**	**LidarZ**	**Description**	**DeltaZ**	**ABSzSDelta**
OT01	1764576.850	188471.706	46.726	46.682	Open Terrain	0.044	0.044
OT02	1748558.634	241328.309	115.941	116.133	Open Terrain	-0.192	0.192
OT03	1733350.188	147041.675	6.616	6.682	Open Terrain	-0.066	0.066
OT04	1714069.210	274604.695	226.421	226.560	Open Terrain	-0.140	0.140
OT05	1793852.778	308910.742	17.014	16.882	Open Terrain	0.132	0.132
OT06	1804571.265	378510.371	42.734	42.285	Open Terrain	0.449	0.449
OT07	1735281.291	352697.178	187.269	186.927	Open Terrain	0.342	0.342
OT08	1767796.289	413977.544	299.452	299.170	Open Terrain	0.283	0.283
OT09	1767601.643	413447.494	291.039	290.739	Open Terrain	0.300	0.300
OT10	1733725.674	411821.136	281.775	281.515	Open Terrain	0.260	0.260
OT11	1733727.499	411812.909	281.761	281.801	Open Terrain	-0.040	0.040
OT12	1785395.945	267440.861	31.302	30.926	Open Terrain	0.376	0.376
OT13	1793057.733	308182.039	17.980	17.885	Open Terrain	0.095	0.095
OT14	1715439.334	273862.198	224.560	224.863	Open Terrain	-0.303	0.303
OT15	1793632.220	266929.229	27.588	27.800	Open Terrain	-0.212	0.212
OT16	1746379.675	241213.062	117.797	118.118	Open Terrain	-0.321	0.321
OT17	1772107.821	187682.871	28.612	28.513	Open Terrain	0.099	0.099
OT18	1681687.996	314135.123	84.308	84.487	Open Terrain	-0.179	0.179
OT19	1737081.728	358599.314	128.378	128.735	Open Terrain	-0.357	0.357
OT20	1804219.559	368142.570	48.822	48.342	Open Terrain	0.480	0.480
OT21	1768019.871	413813.672	300.531	300.745	Open Terrain	-0.214	0.214
OT22	1731081.579	416813.486	215.885	216.093	Open Terrain	-0.208	0.208
OT23	1726922.669	141470.489	2.722	2.935	Open Terrain	-0.213	0.213
UB01	1768036.519	187953.799	26.329	25.918	Urban	0.411	0.411
UB02	1772014.792	197122.237	16.571	16.282	Urban	0.289	0.289
UB03	1714177.325	189525.178	125.220	125.053	Urban	0.167	0.167
UB04	1731678.112	198826.328	150.166	150.263	Urban	-0.097	0.097
UB05	1722181.222	195580.508	151.369	151.804	Urban	-0.435	0.435
UB06	1722233.069	195615.133	150.995	151.501	Urban	-0.506	0.506
UB07	1740885.494	233675.949	151.050	150.822	Urban	0.228	0.228
UB08	1751569.230	241855.796	156.529	156.635	Urban	-0.106	0.106
UB09	1734569.326	140936.525	13.823	13.822	Urban	0.001	0.001
UB10	1732885.192	148017.360	6.522	6.229	Urban	0.293	0.293
UB11	1715467.016	272233.000	219.792	219.801	Urban	-0.009	0.009
UB12	1716309.247	274390.546	215.433	215.399	Urban	0.034	0.034
UB13	1793264.551	310910.233	19.280	18.991	Urban	0.289	0.289
UB14	1792712.966	307408.235	23.408	23.229	Urban	0.179	0.179
UB15	1681841.758	313884.088	76.994	77.052	Urban	-0.057	0.057
UB16	1804097.841	367200.895	45.485	45.180	Urban	0.306	0.306

UB17	1804336.667	368094.263	49.707	49.308	Urban	0.399	0.399
UB18	1737434.980	362944.877	148.200	148.116	Urban	0.084	0.084
UB19	1737440.491	362944.352	147.843	148.010	Urban	-0.168	0.168
UB20	1739170.402	368578.772	201.496	201.875	Urban	-0.379	0.379
UB21	1739144.071	368586.141	201.334	201.486	Urban	-0.151	0.151
UB22	1733440.395	411137.336	313.650	313.535	Urban	0.114	0.114
UB23	1733435.463	411129.753	313.914	313.807	Urban	0.106	0.106
UB24	1767881.460	413984.363	301.245	301.008	Urban	0.237	0.237
UB25	1786572.638	263812.280	33.557	33.007	Urban	0.550	0.550
UB26	1789502.518	271846.632	30.996	30.831	Urban	0.165	0.165
HG01	1772176.518	183012.970	21.484	20.921	High Grass	0.563	0.563
HG02	1772034.365	191265.258	26.187	25.218	High Grass	0.969	0.969
HG03	1723338.491	196583.410	147.328	147.714	High Grass	-0.386	0.386
HG04	1749246.284	241060.304	134.944	135.937	High Grass	-0.993	0.993
HG05	1735272.130	137296.629	3.649	3.921	High Grass	-0.272	0.272
HG06	1730132.944	143155.717	6.648	7.188	High Grass	-0.540	0.540
HG07	1711936.043	273535.289	200.246	200.677	High Grass	-0.431	0.431
HG08	1714948.235	271685.736	202.189	202.201	High Grass	-0.012	0.012
HG09	1793064.243	308099.746	17.380	17.717	High Grass	-0.337	0.337
HG10	1794993.299	313680.130	19.760	20.089	High Grass	-0.329	0.329
HG11	1685861.651	317210.092	190.719	190.778	High Grass	-0.059	0.059
HG12	1804459.376	377353.255	46.637	47.039	High Grass	-0.402	0.402
HG13	1803871.011	360581.543	42.595	42.581	High Grass	0.014	0.014
HG14	1738877.073	367535.023	197.601	197.856	High Grass	-0.255	0.255
HG15	1738885.478	367526.172	197.661	197.630	High Grass	0.031	0.031
HG16	1731551.529	352906.286	273.735	274.531	High Grass	-0.796	0.796
HG17	1767994.856	413837.516	300.874	300.839	High Grass	0.035	0.035
HG18	1767948.252	413944.689	300.771	301.357	High Grass	-0.586	0.586
HG19	1723638.973	410056.011	179.302	179.530	High Grass	-0.229	0.229
HG20	1723639.089	410056.170	179.392	179.599	High Grass	-0.207	0.207
HG21	1723642.615	410050.466	179.863	179.374	High Grass	0.489	0.489
TR01	1772298.965	197265.091	13.883	13.592	Trees	0.291	0.291
TR02	1772178.928	183241.288	20.178	20.551	Trees	-0.373	0.373
TR03	1722291.266	195720.674	149.995	150.374	Trees	-0.379	0.379
TR04	1732160.187	198410.236	134.905	135.654	Trees	-0.749	0.749
TR05	1752551.345	240383.448	187.143	187.026	Trees	0.117	0.117
TR06	1745958.049	233328.410	101.091	101.596	Trees	-0.505	0.505
TR07	1734064.315	154193.787	18.298	18.393	Trees	-0.095	0.095
TR08	1725375.636	152226.150	14.429	15.026	Trees	-0.597	0.597
TR09	1713813.214	275904.576	226.745	226.796	Trees	-0.050	0.050
TR10	1717515.525	273089.663	208.561	209.110	Trees	-0.550	0.550

TR11	1795005.698	313727.376	19.510	19.832	Trees	-0.322	0.322
TR12	1792447.884	307252.379	20.980	20.929	Trees	0.050	0.050
TR13	1685356.018	315758.657	162.619	162.836	Trees	-0.217	0.217
TR14	1803855.763	360659.731	43.220	43.099	Trees	0.121	0.121
TR15	1739087.420	348015.112	109.460	110.164	Trees	-0.704	0.704
TR16	1739091.806	348015.327	109.381	110.157	Trees	-0.776	0.776
TR17	1767665.976	413846.666	297.355	297.603	Trees	-0.248	0.248
TR18	1767578.592	413685.358	292.929	293.587	Trees	-0.659	0.659
TR19	1767621.303	413674.766	295.189	295.534	Trees	-0.345	0.345
TR20	1793275.078	266858.612	26.373	27.168	Trees	-0.795	0.795
TR21	1790696.024	268301.866	32.782	33.102	Trees	-0.321	0.321
LT01	1771873.482	192858.781	25.202	24.812	Low Trees	0.390	0.390
LT02	1722981.451	209712.468	163.783	164.688	Low Trees	-0.905	0.905
LT03	1723187.050	196521.871	146.302	146.752	Low Trees	-0.450	0.450
LT04	1744135.850	241032.401	161.289	161.576	Low Trees	-0.287	0.287
LT05	1748511.703	241610.973	113.421	114.311	Low Trees	-0.891	0.891
LT06	1713808.113	274939.751	225.452	225.236	Low Trees	0.216	0.216
LT07	1713730.683	275982.882	226.552	226.475	Low Trees	0.077	0.077
LT08	1794257.049	308089.102	20.248	20.304	Low Trees	-0.056	0.056
LT09	1684189.550	312599.765	110.459	111.385	Low Trees	-0.926	0.926
LT10	1804341.473	368606.986	49.049	49.017	Low Trees	0.032	0.032
LT11	1803689.701	362749.427	34.292	34.041	Low Trees	0.251	0.251
LT12	1736995.263	358609.895	129.856	130.507	Low Trees	-0.652	0.652
LT13	1736994.964	358610.167	129.830	130.559	Low Trees	-0.729	0.729
LT14	1738645.017	371052.320	250.038	249.797	Low Trees	0.241	0.241
LT15	1738645.156	371052.556	250.005	249.814	Low Trees	0.190	0.190
LT16	1767832.076	413906.832	301.375	301.217	Low Trees	0.157	0.157
LT17	1767984.001	413786.752	303.800	303.335	Low Trees	0.465	0.465
LT18	1738637.270	407731.304	325.781	326.275	Low Trees	-0.494	0.494
LT19	1738639.400	407731.058	325.293	325.787	Low Trees	-0.494	0.494
LT20	1787863.886	266284.666	24.600	25.315	Low Trees	-0.715	0.715

Table 7: LiDAR Checkpoints

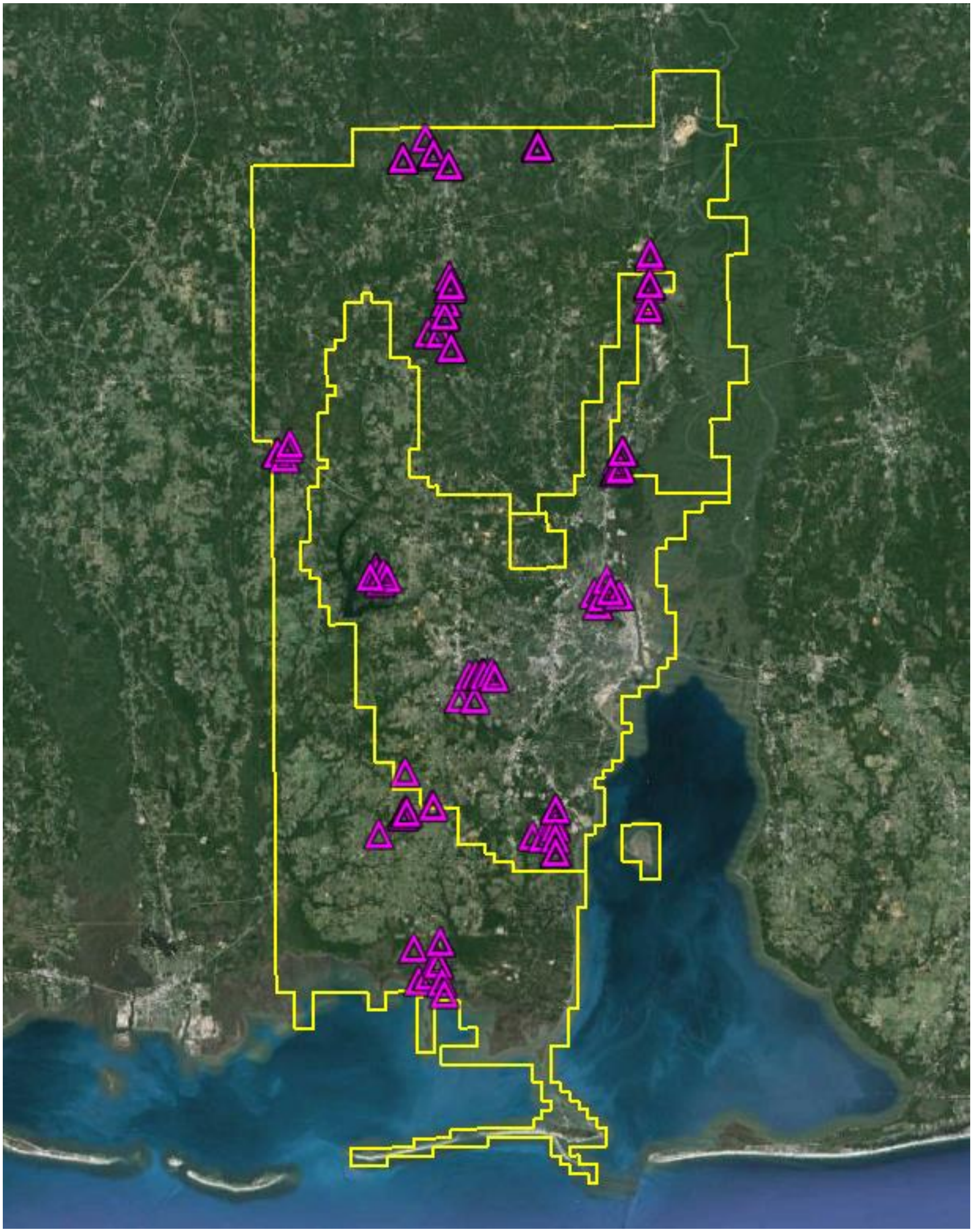

Figure 4: Check Point Distribution

Appendix A: GPS Processing Reports

Inertial Explorer Version 8.50.4320

Plots by Mission of the Overall Map, Estimated Position Accuracy, Height Profile, Combined Separation, and PDOP.

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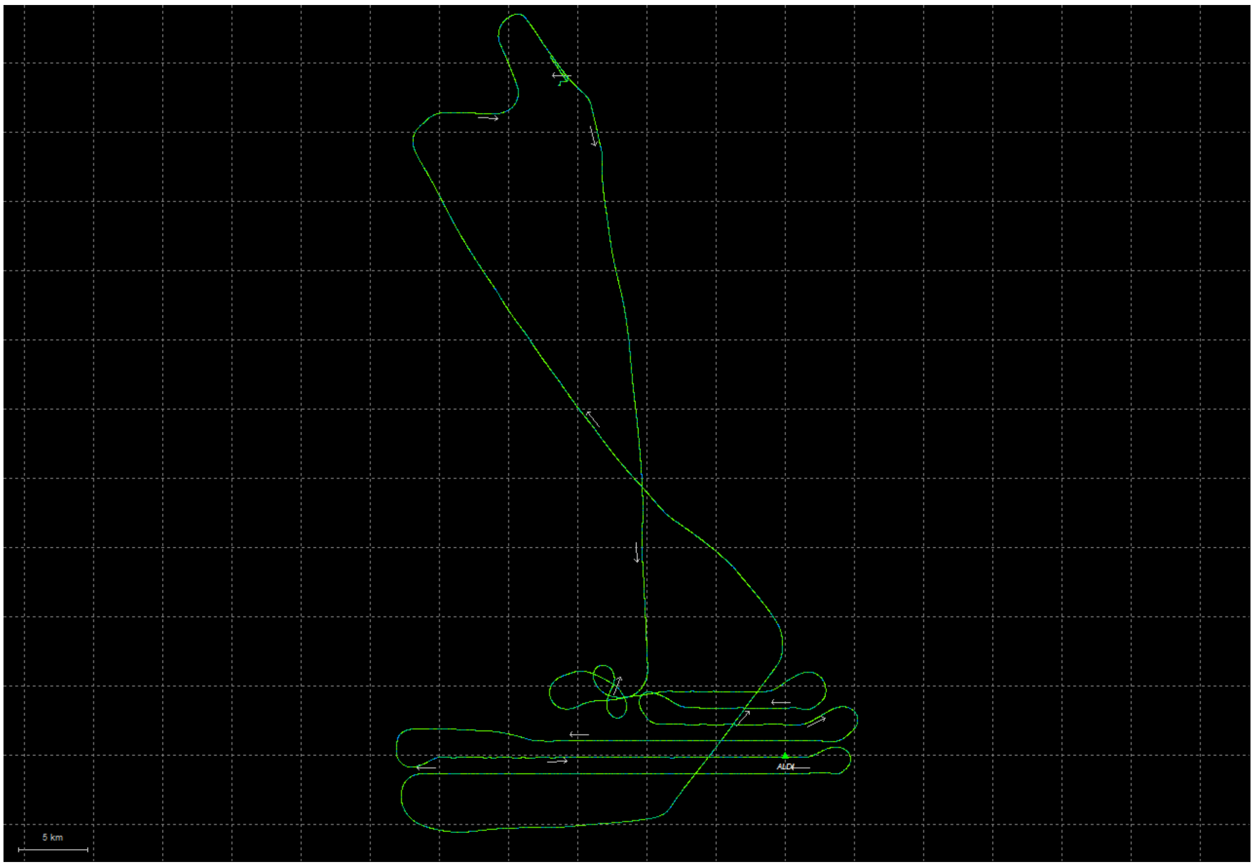

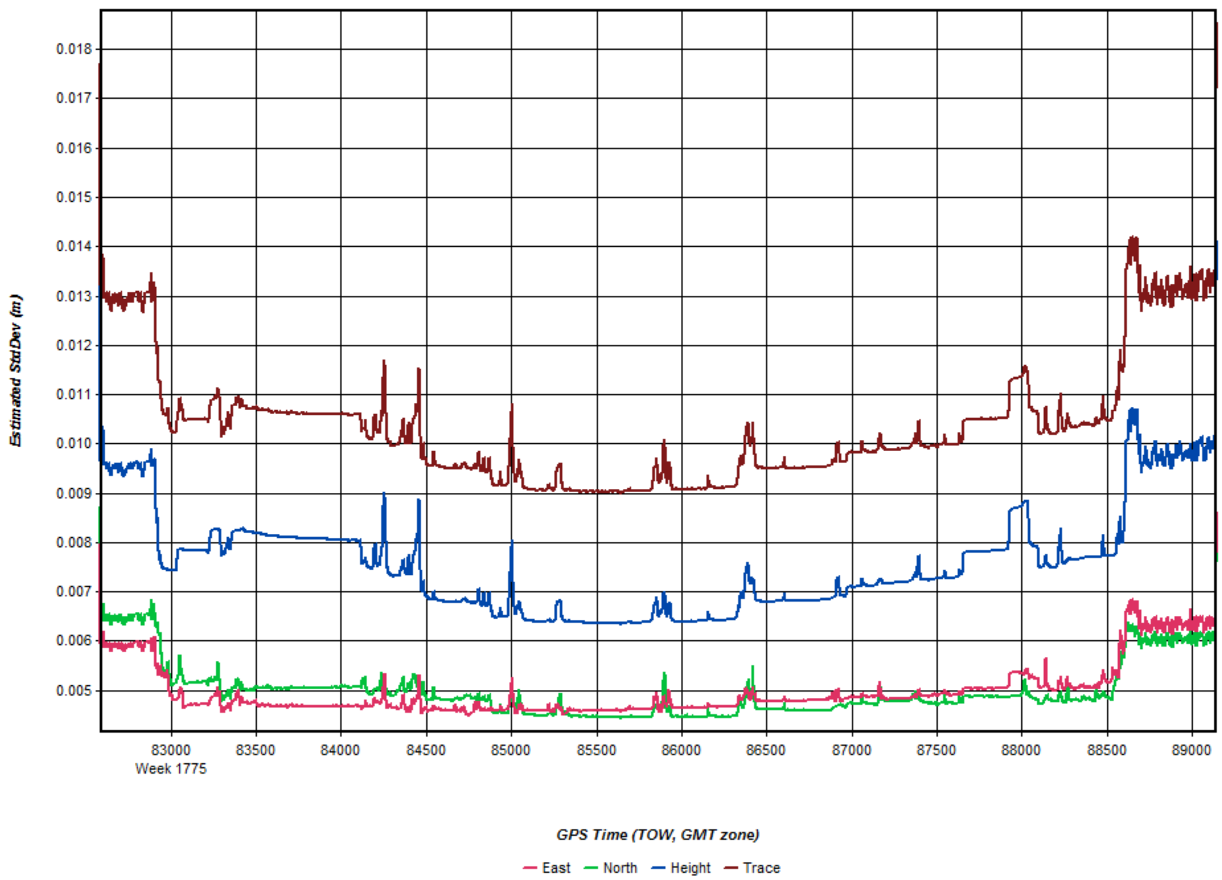
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0.014
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0.008
0.007
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83000
Week 1775
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84000
84500
85000
85500
86000
86500
87000
87500
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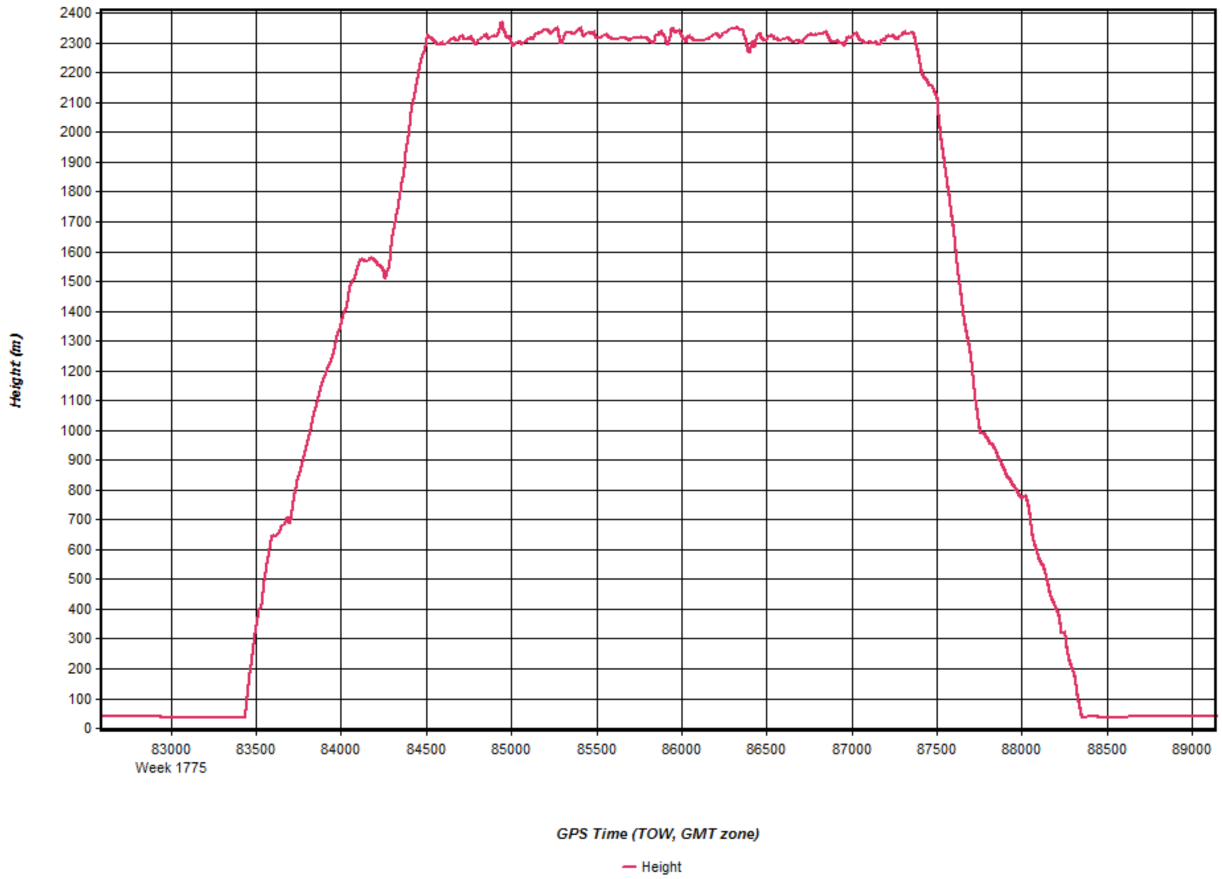
GPS Time (TOW, GMT zone)
East
North
Height
Trace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1800
1700
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1400
1300
1200
1100
1000
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700
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500
400
300
200
100
0
Height (m)
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Week 1775
83500
84000
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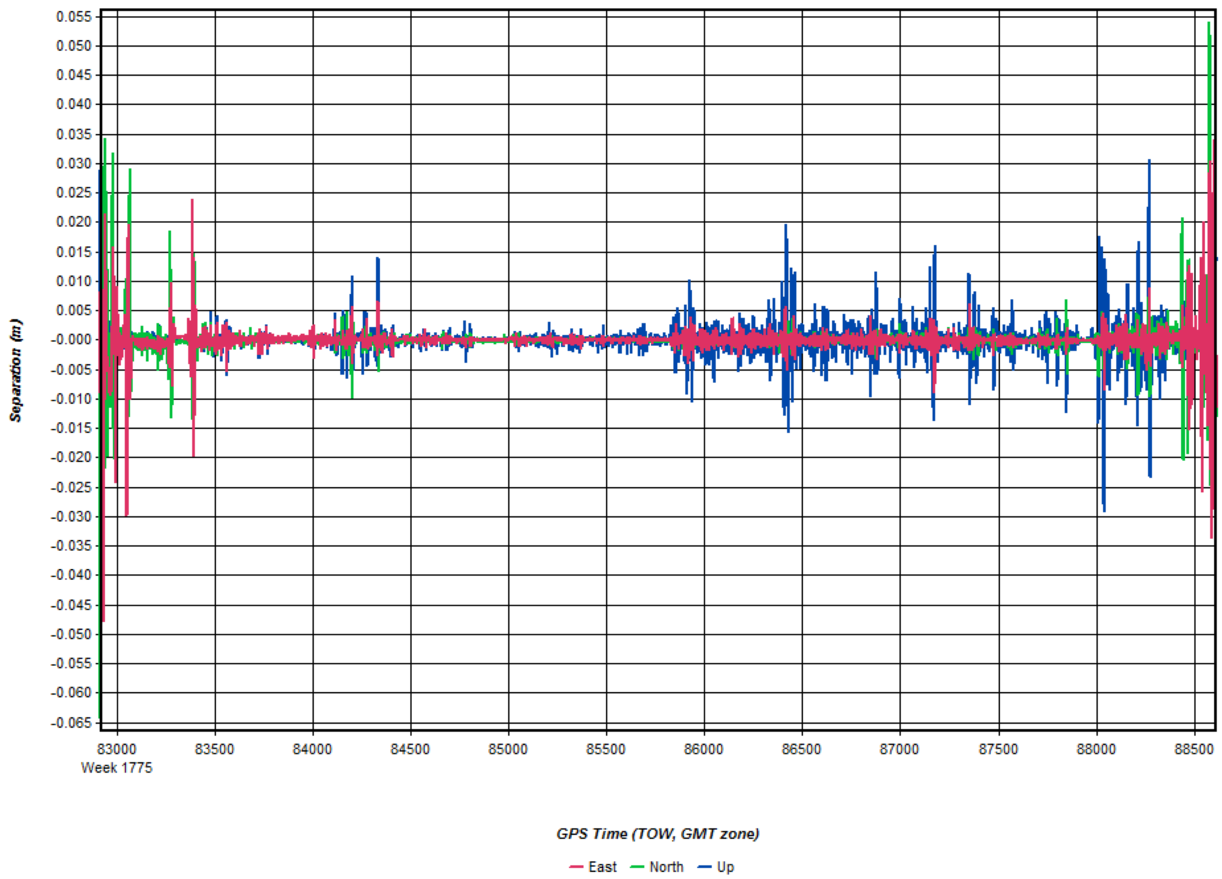
85000
85500
86000
86500
87000
87500
88000
88500
89000
GPS Time (TOW, GMT zone)
Height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0.045
0.040
0.035
0.030
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-0.035
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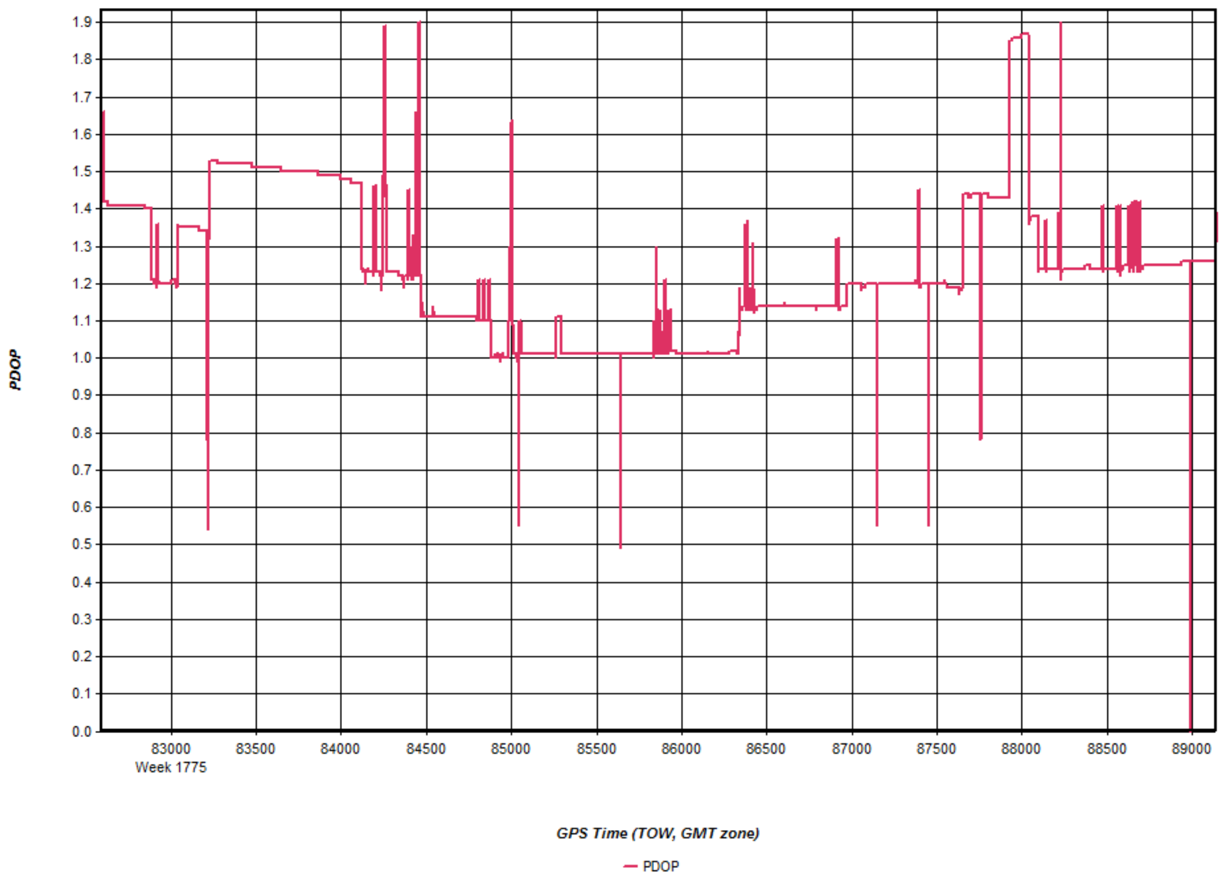
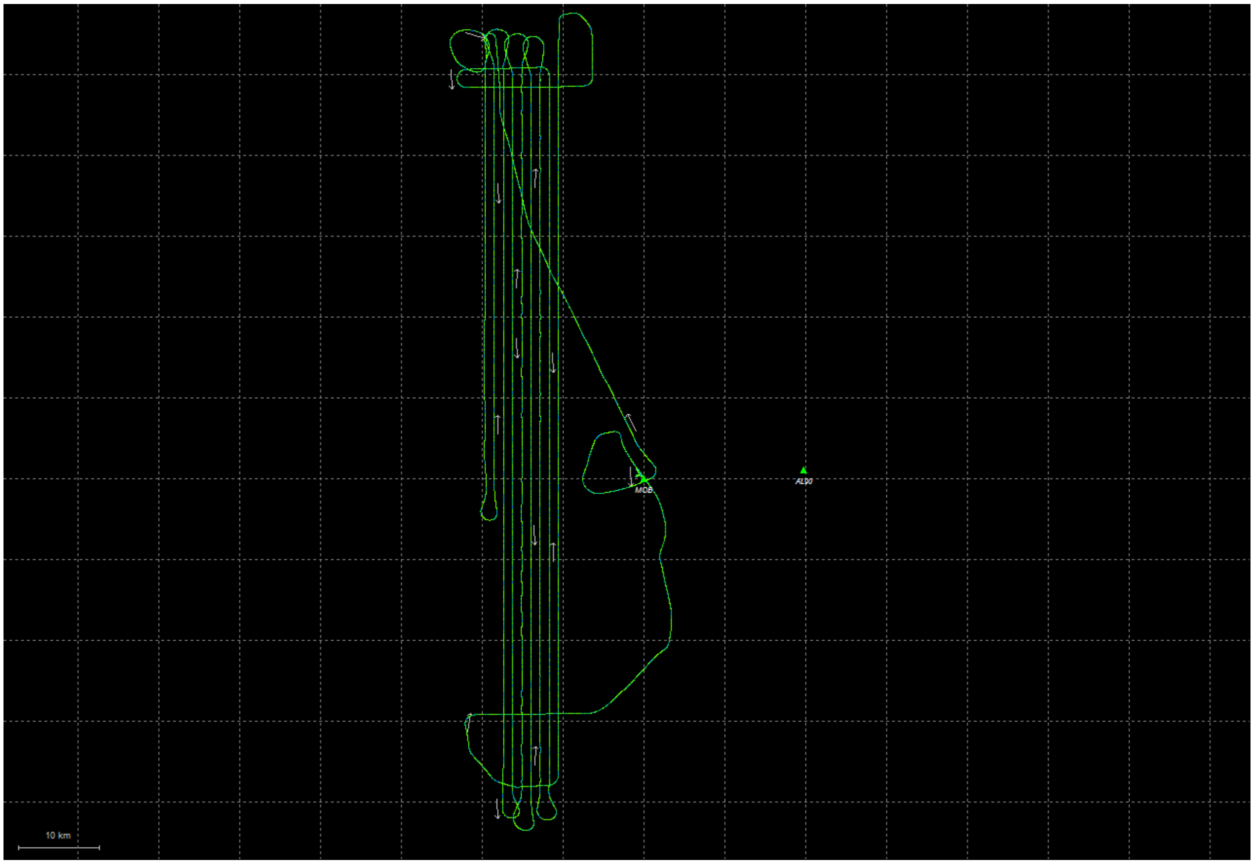
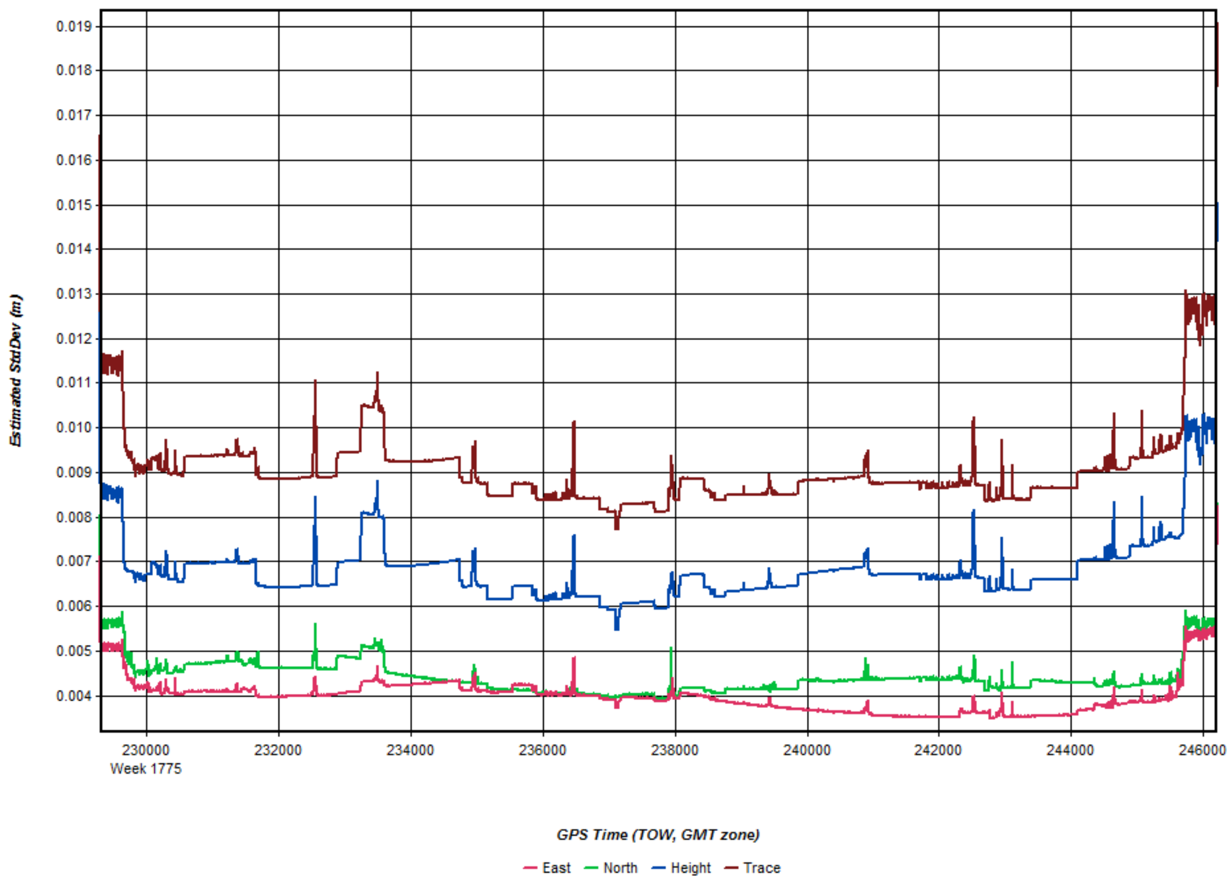
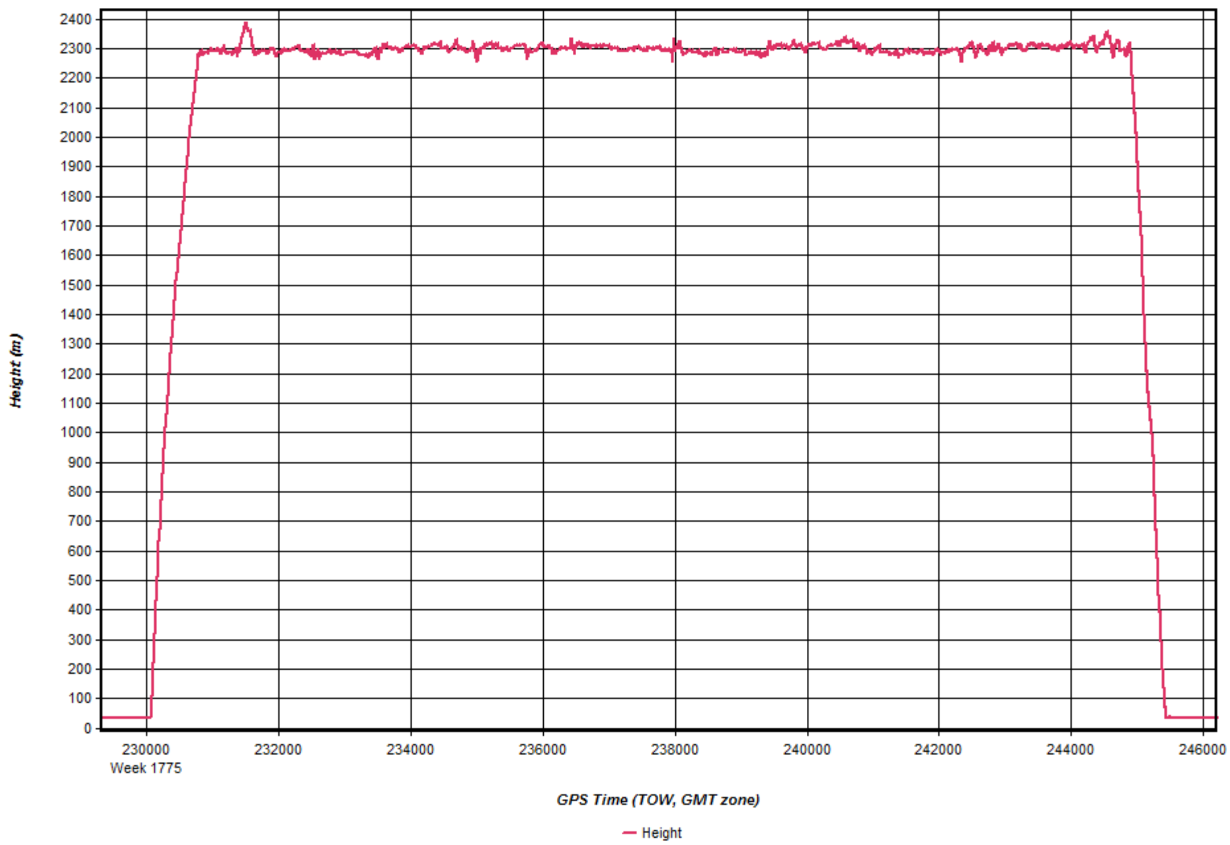
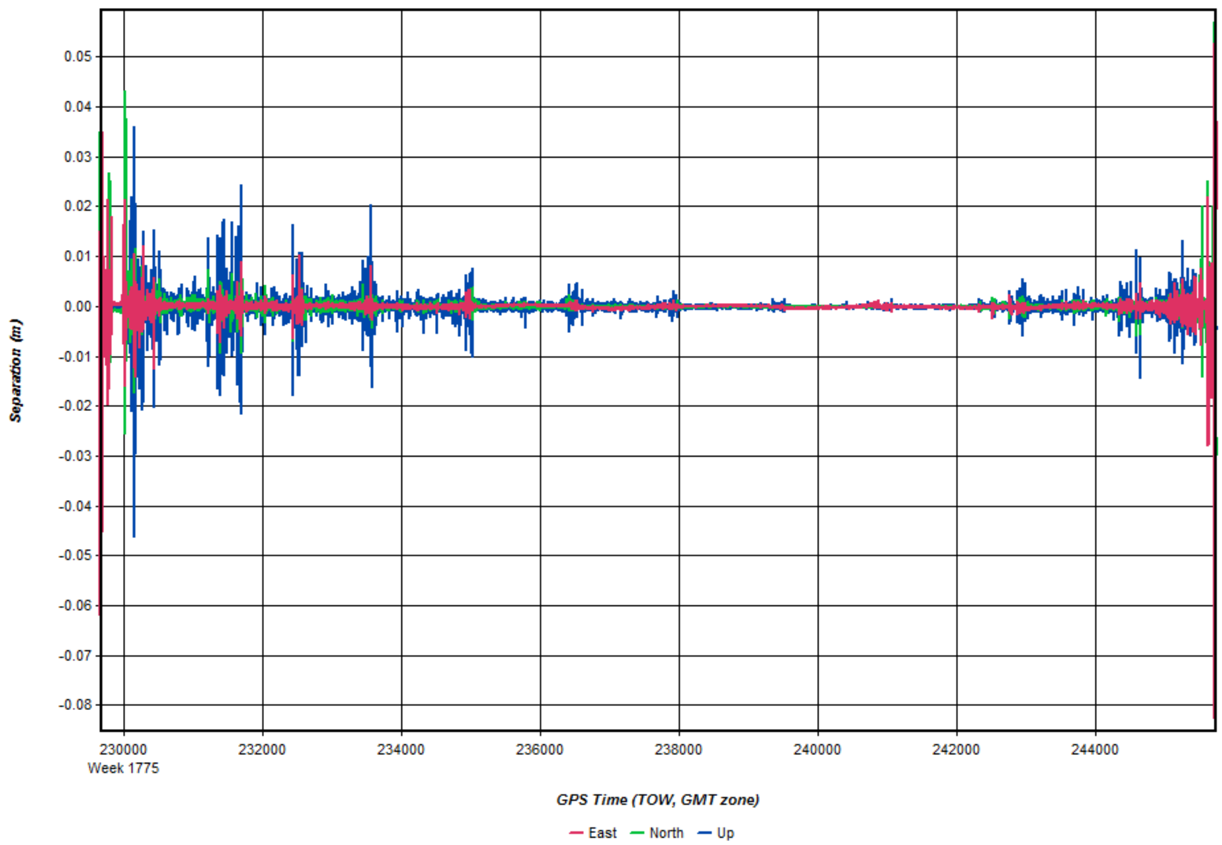
-0.045
-0.050
-0.055
-0.060
-0.065
83000
Week 1775
83500
84000
84500
85000
85500
86000
86500
87000
87500
88000
88500
GPS Time (TOW, GMT zone)
East
North
Up

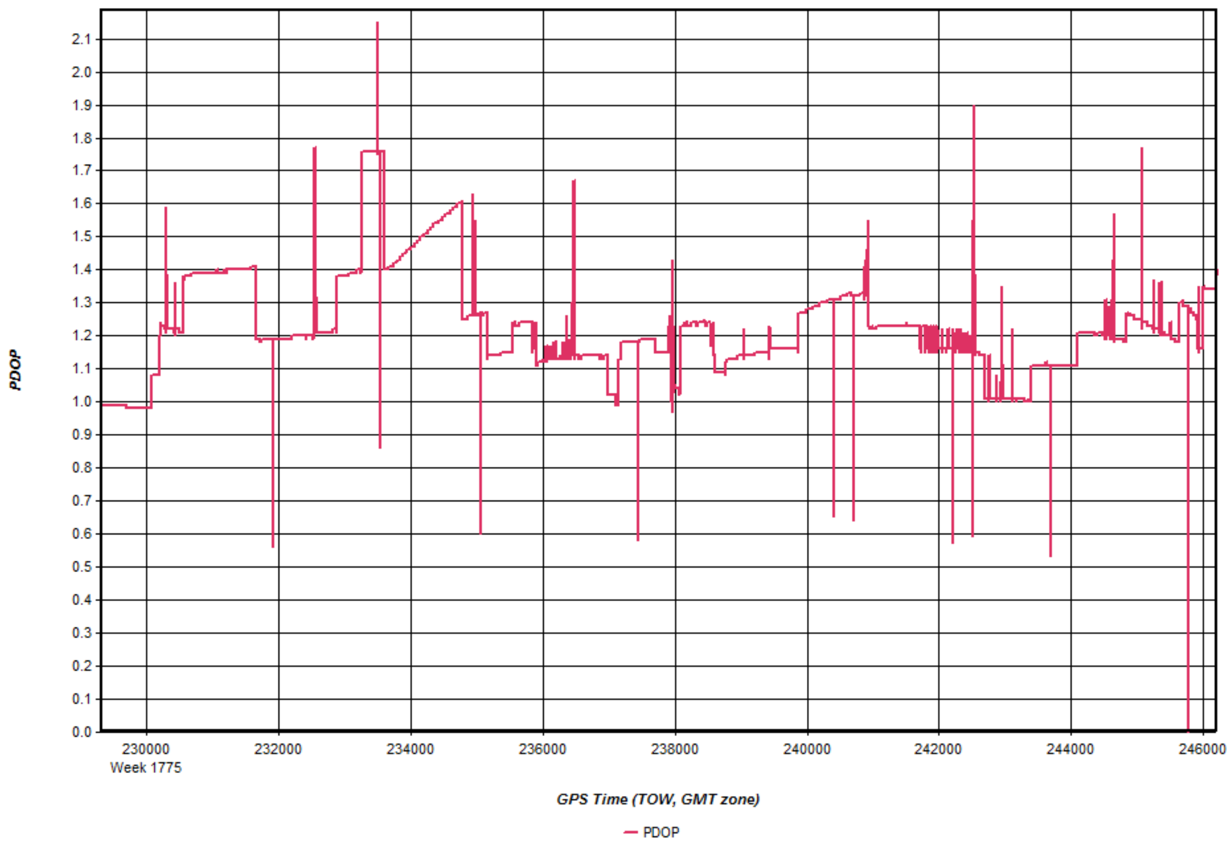

1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
PDOP
83000
Week 1775
83500
84000
84500
85000
85500
86000
86500
87000
87500
88000
88500
89000
GPS Time (TOW, GMT zone)
PDOP


MOB
AL00
10 km


0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
Estimated StdDev (m)
230000
Week 1775
232000
234000
236000
238000
240000
242000
244000
246000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

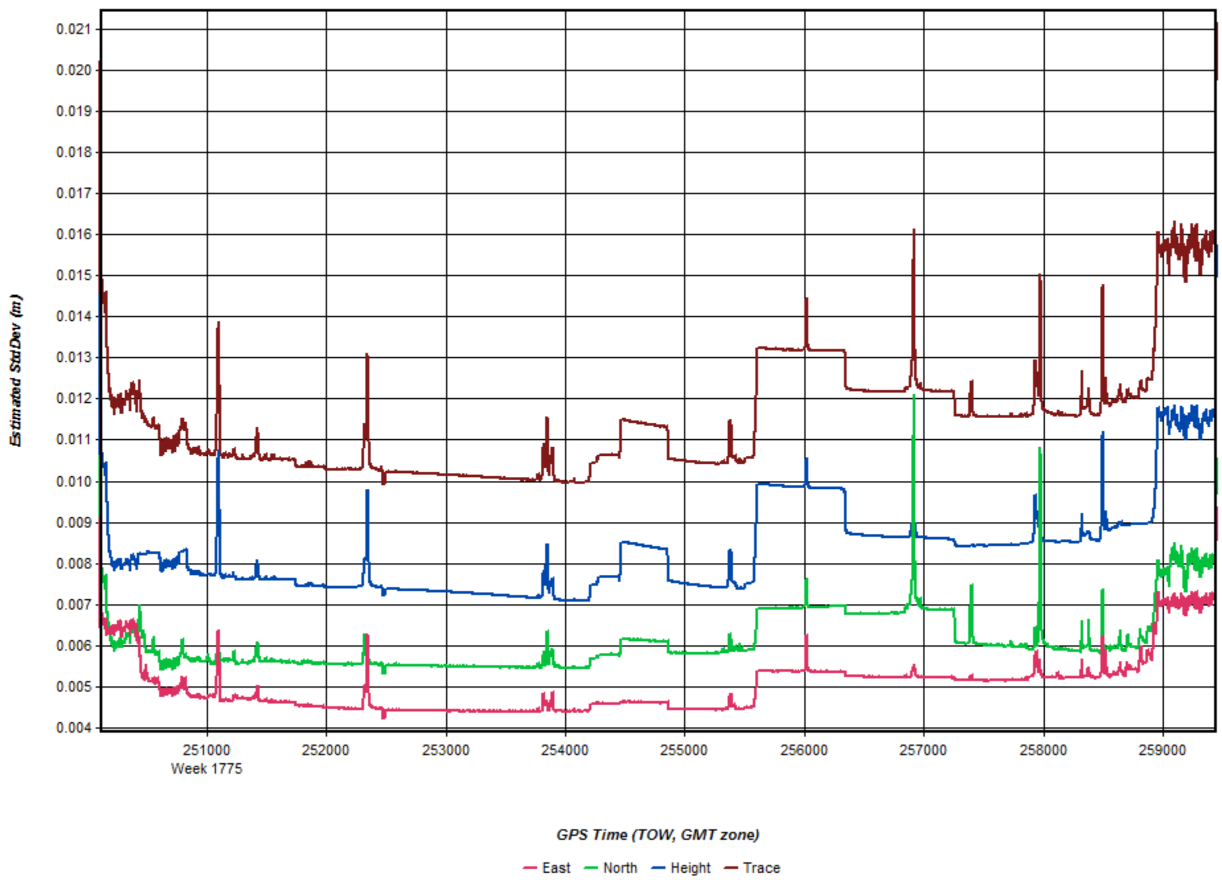

2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Height (m)
230000
Week 1775
232000
234000
236000
238000
240000
242000
244000
246000
GPS Time (TOW, GMT zone)
Height

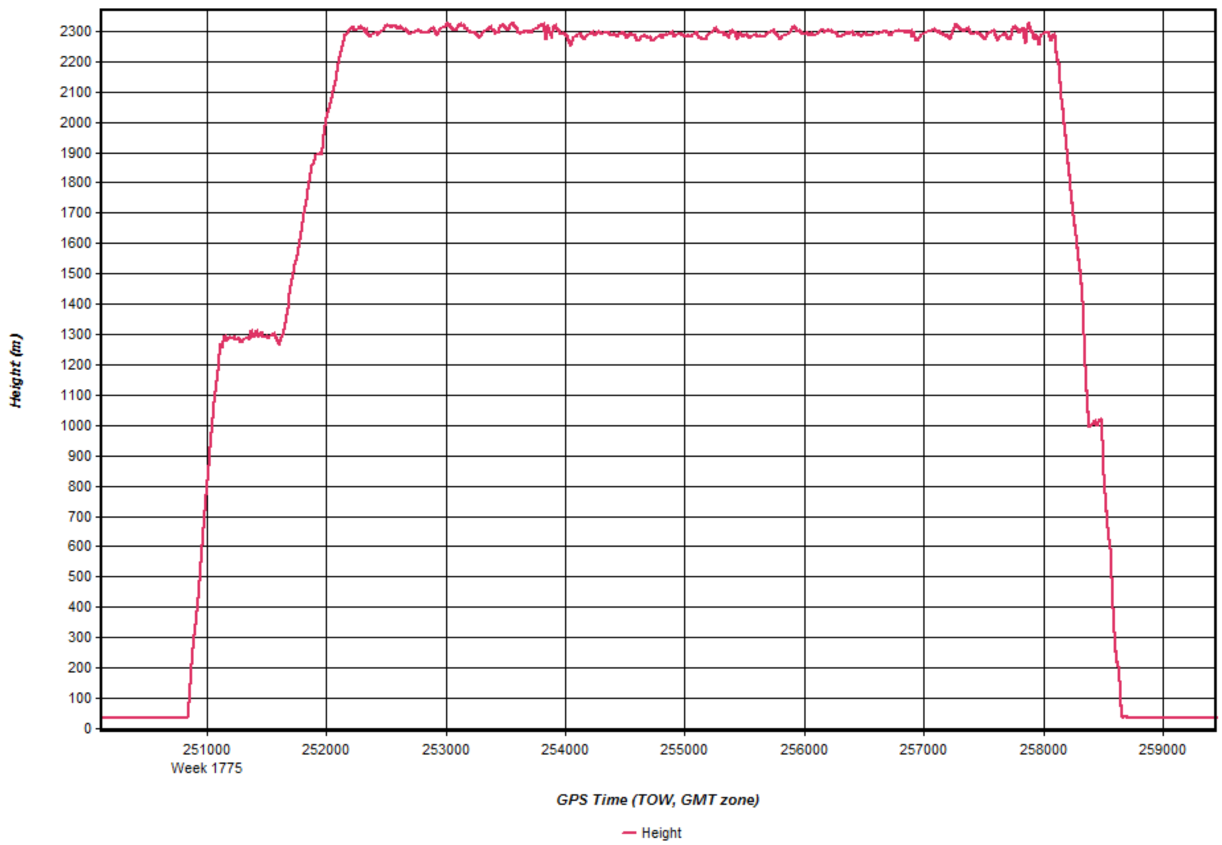

0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
Separation (m)
230000
Week 1775
232000
234000
236000
238000
240000
242000
244000
GPS Time (TOW, GMT zone)
East
North
Up

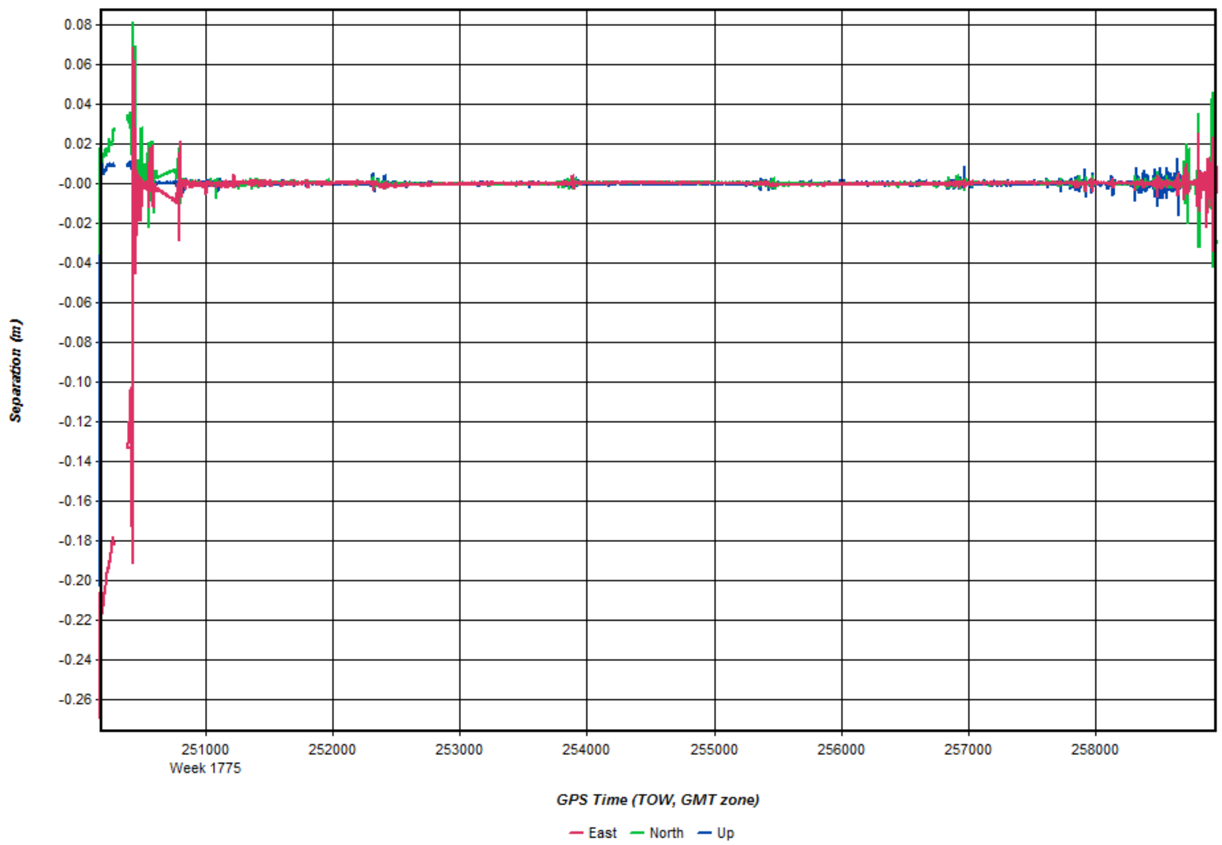

PDOP
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
230000
Week 1775
232000
234000
236000
238000
240000
242000
244000
246000
GPS Time (TOW, GMT zone)
PDOP

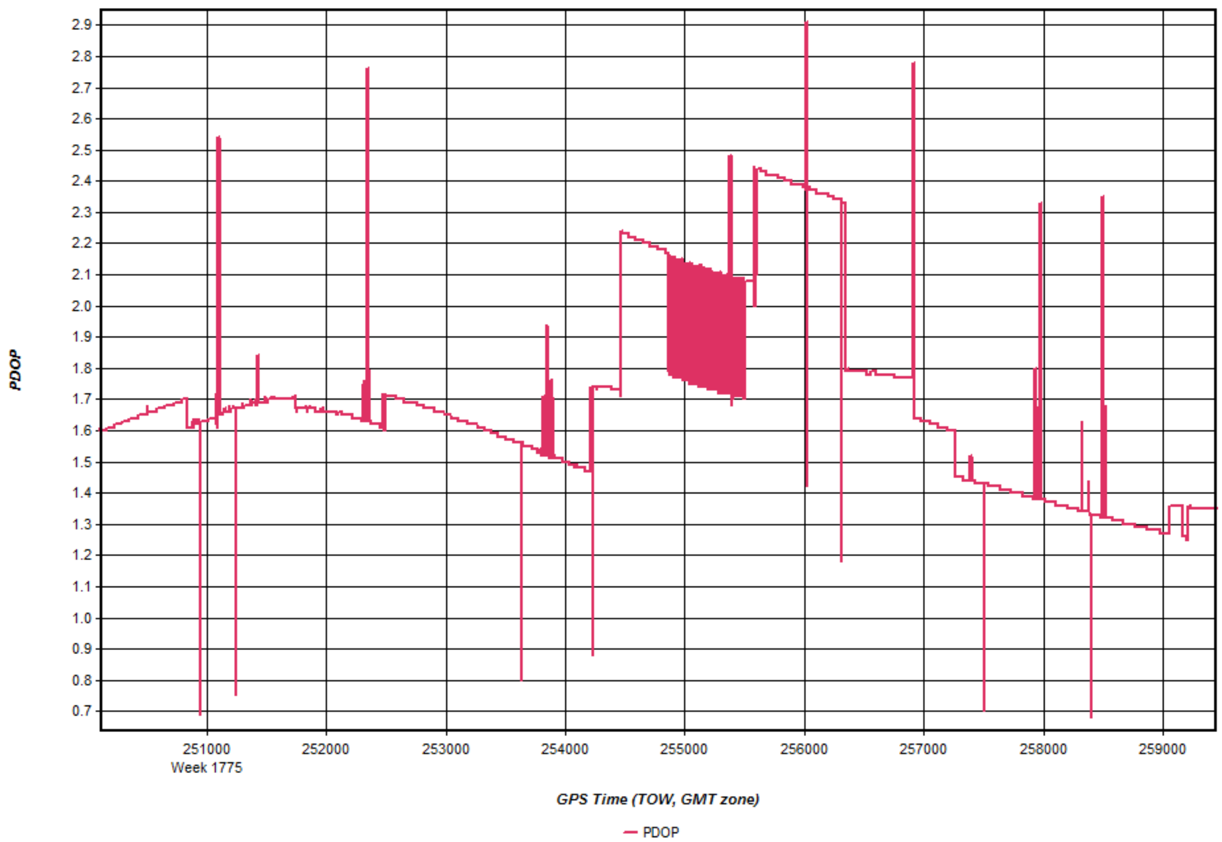
JD14014F02


MOB
AL00
10 km

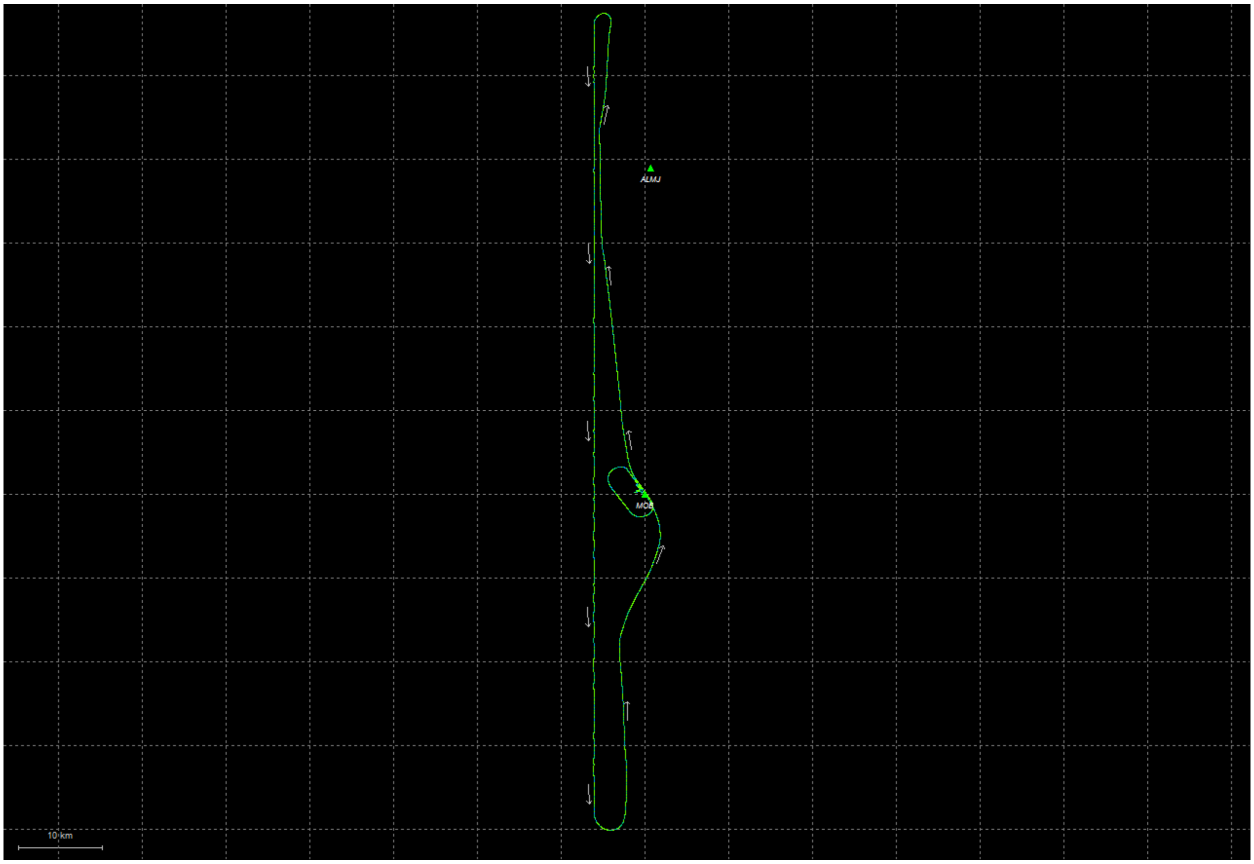

Estimated StdDev (m)
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
251000
Week 1775
252000
253000
254000
255000
256000
257000
258000
259000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

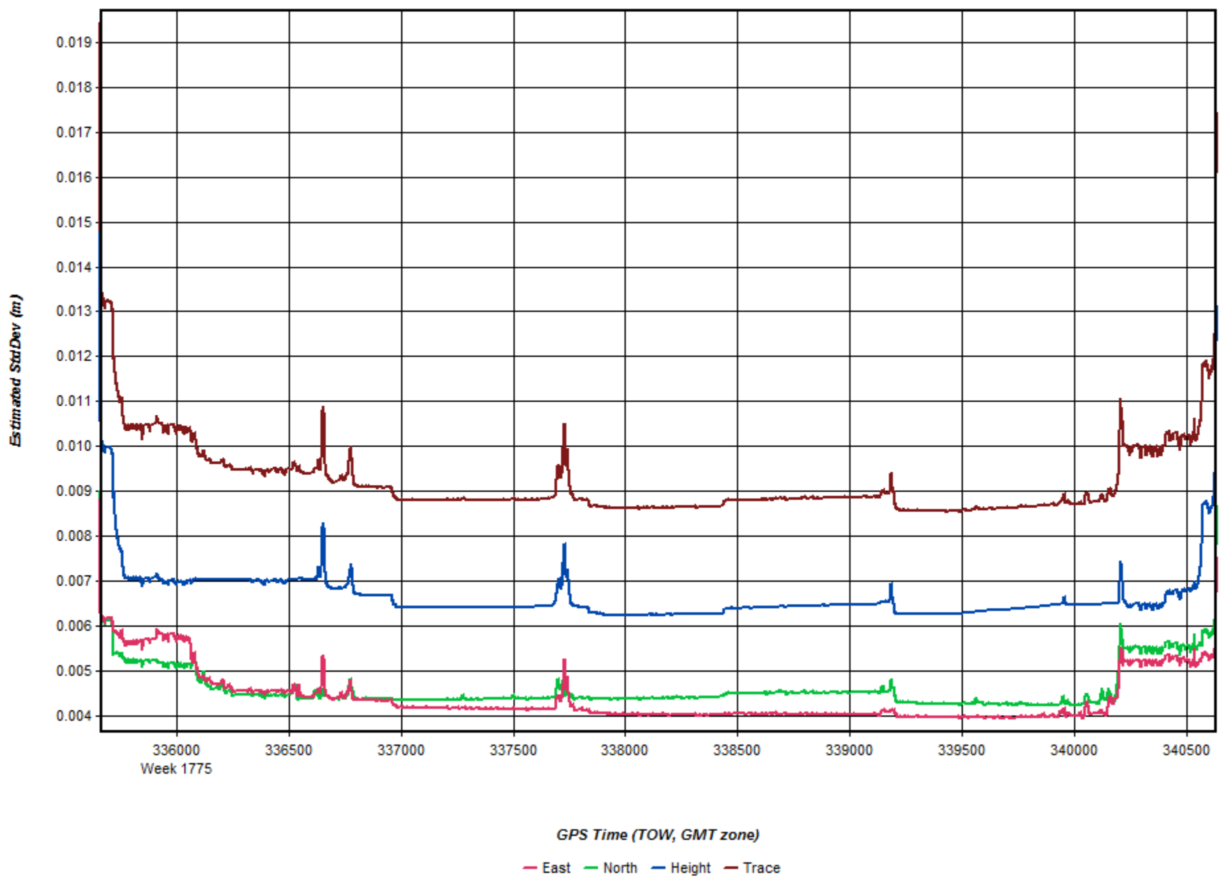

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
251000
Week 1775
252000
253000
254000
255000
256000
257000
258000
259000
GPS Time (TOW, GMT zone)
Height

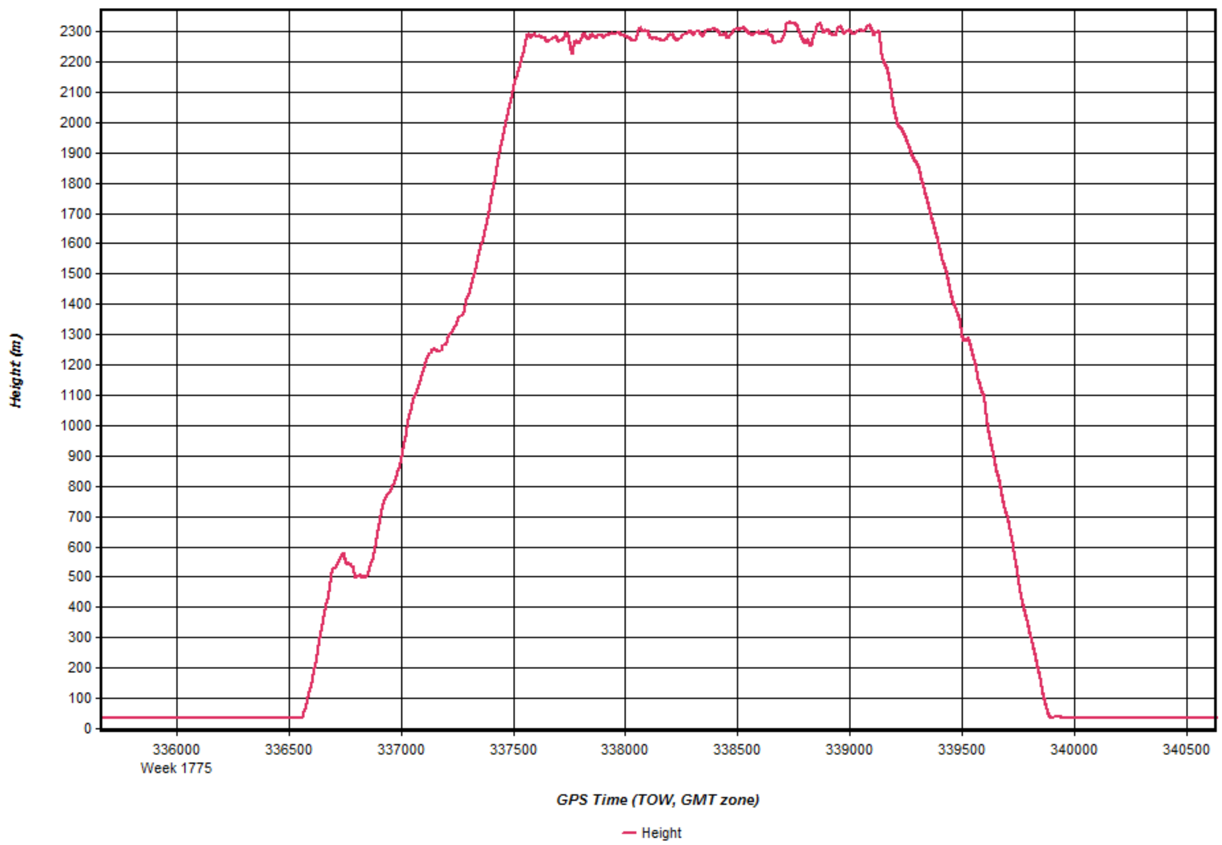

0.08
0.06
0.04
0.02
-0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
-0.22
-0.24
-0.26
Separation (m)
251000
Week 1775
252000
253000
254000
255000
256000
257000
258000
GPS Time (TOW, GMT zone)
East
North
Up

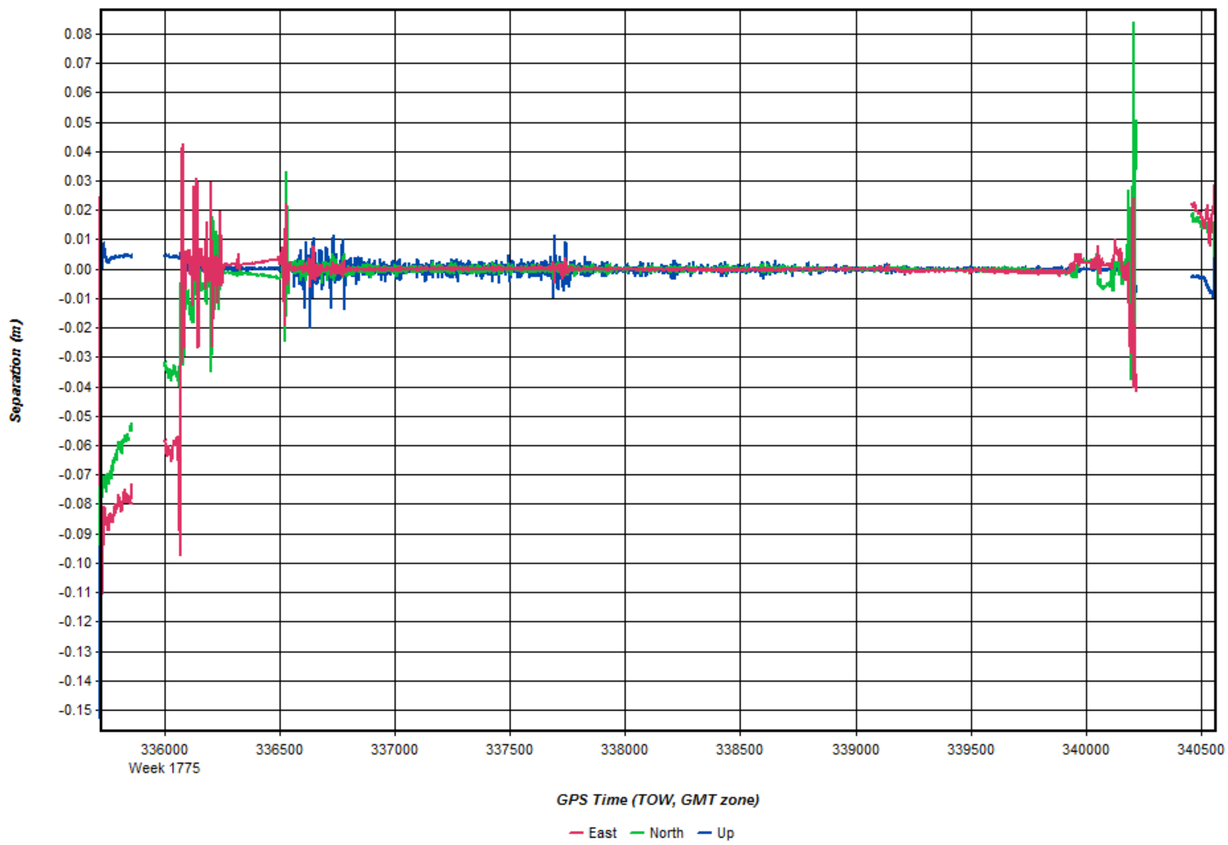

2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
PDOP
251000
Week 1775
252000
253000
254000
255000
256000
257000
258000
259000
GPS Time (TOW, GMT zone)
PDOP

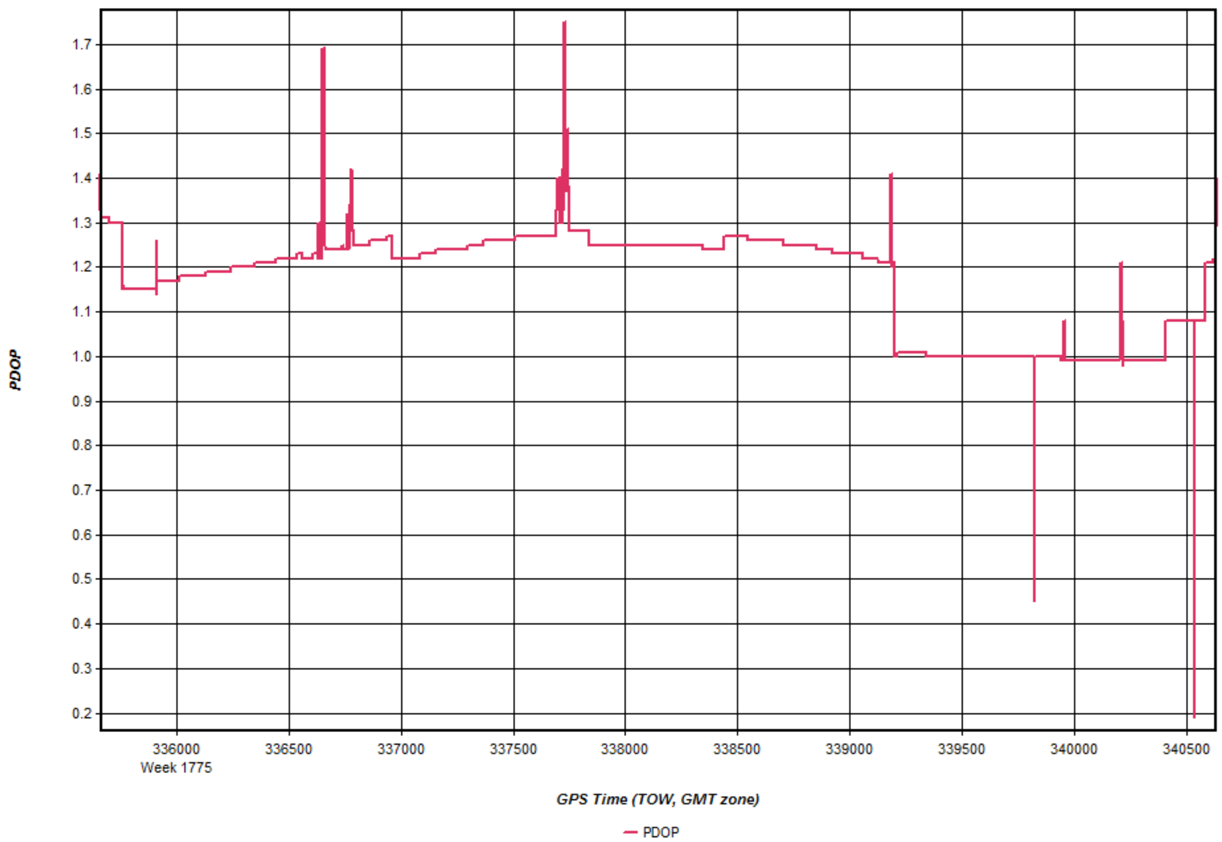
JD14015F01

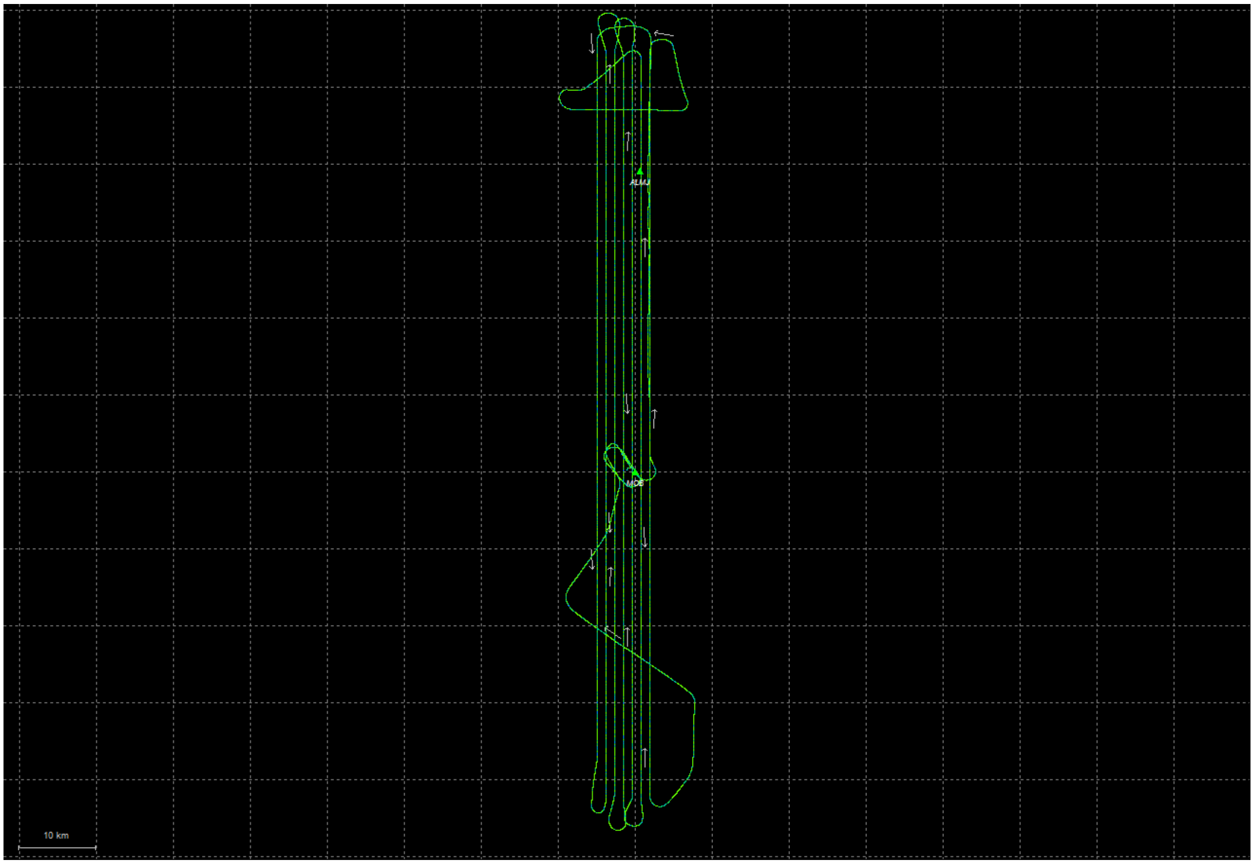

ALMJ
MCB
10 km

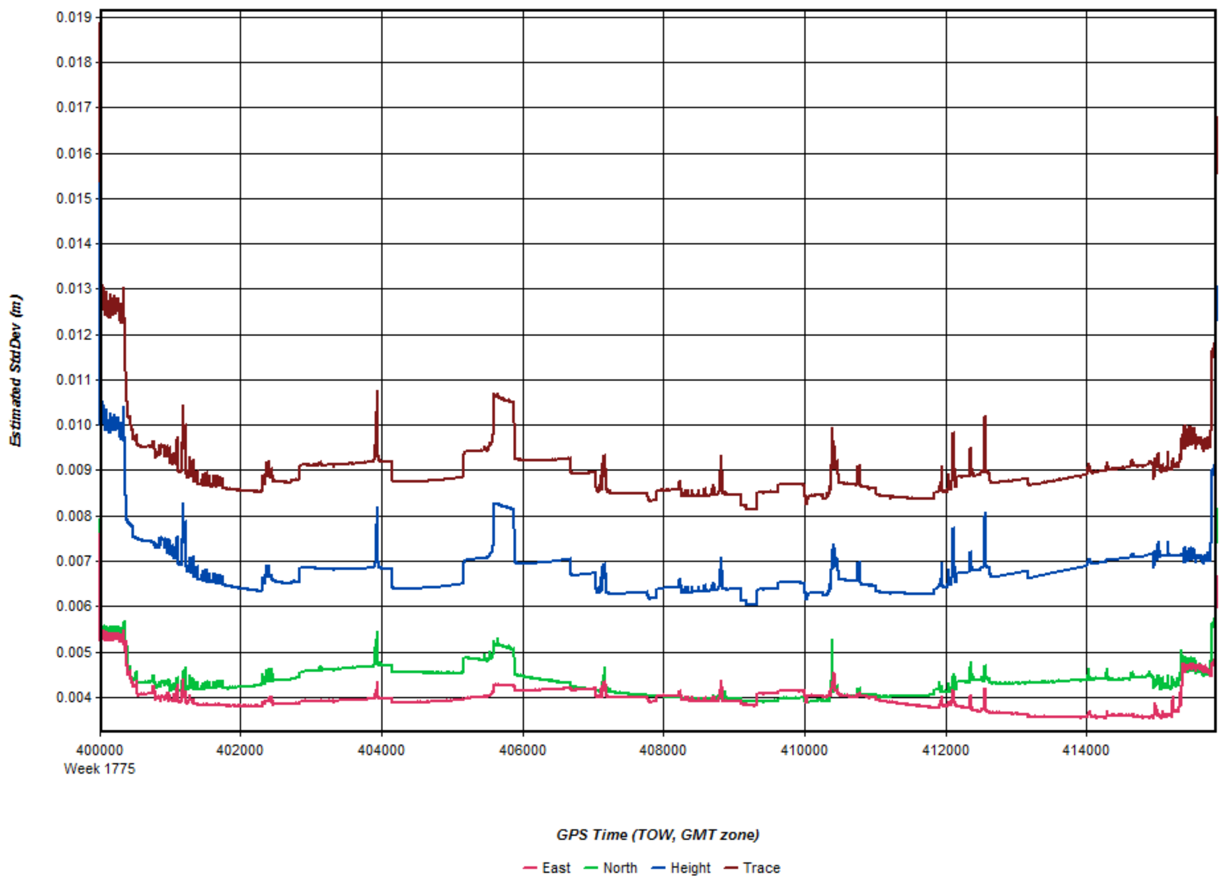

Estimated StdDev (m)
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
336000
Week 1775
336500
337000
337500
338000
338500
339000
339500
340000
340500
GPS Time (TOW, GMT zone)
East
North
Height
Trace

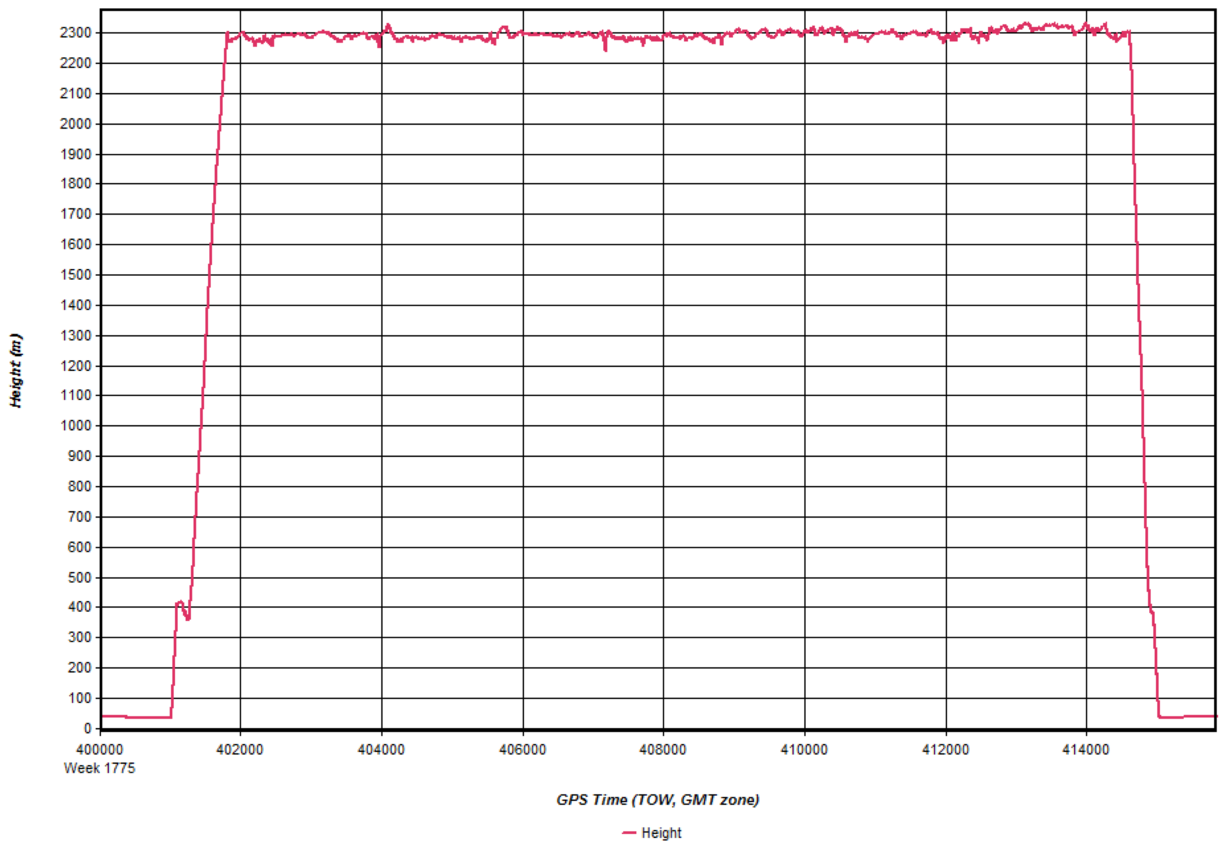

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
336000
Week 1775
336500
337000
337500
338000
338500
339000
339500
340000
340500
GPS Time (TOW, GMT zone)
Height

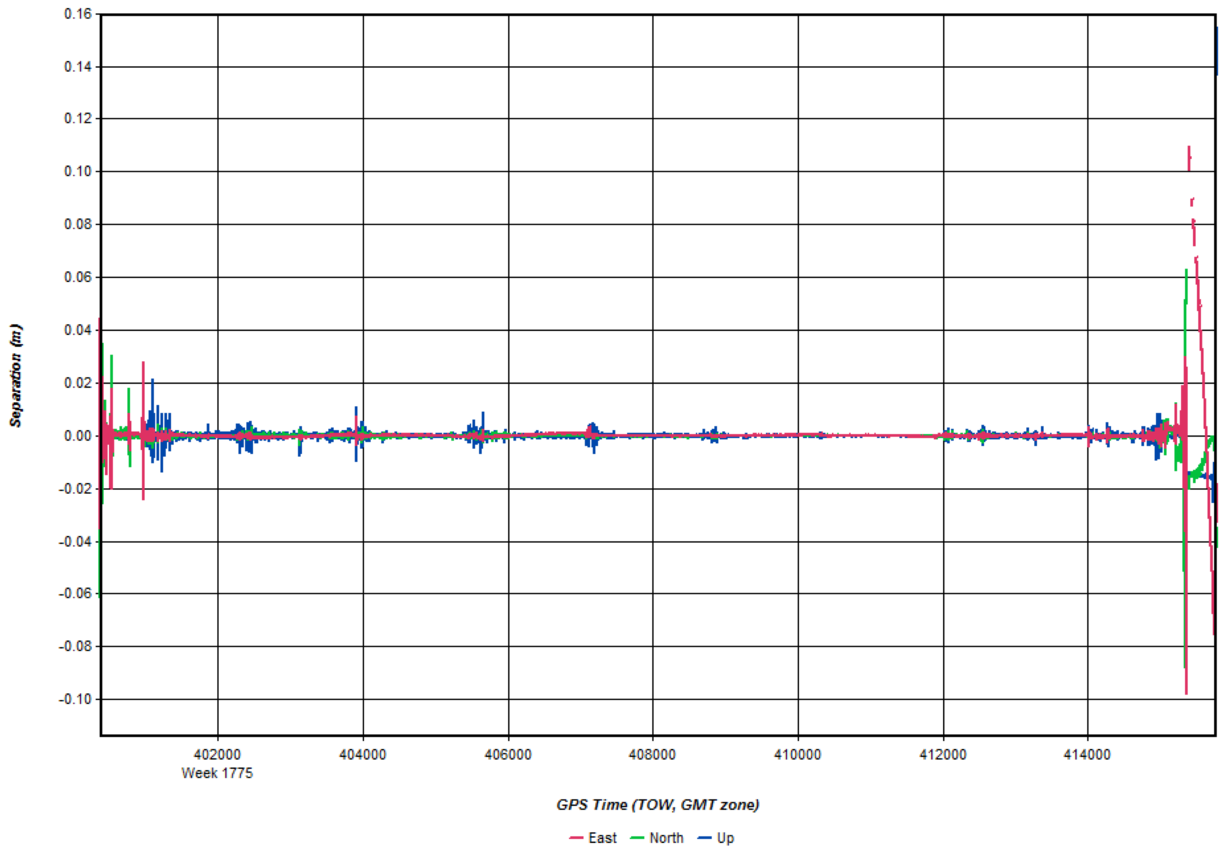

0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
Separation (m)
336000
Week 1775
336500
337000
337500
338000
338500
339000
339500
340000
340500
GPS Time (TOW, GMT zone)
East
North
Up

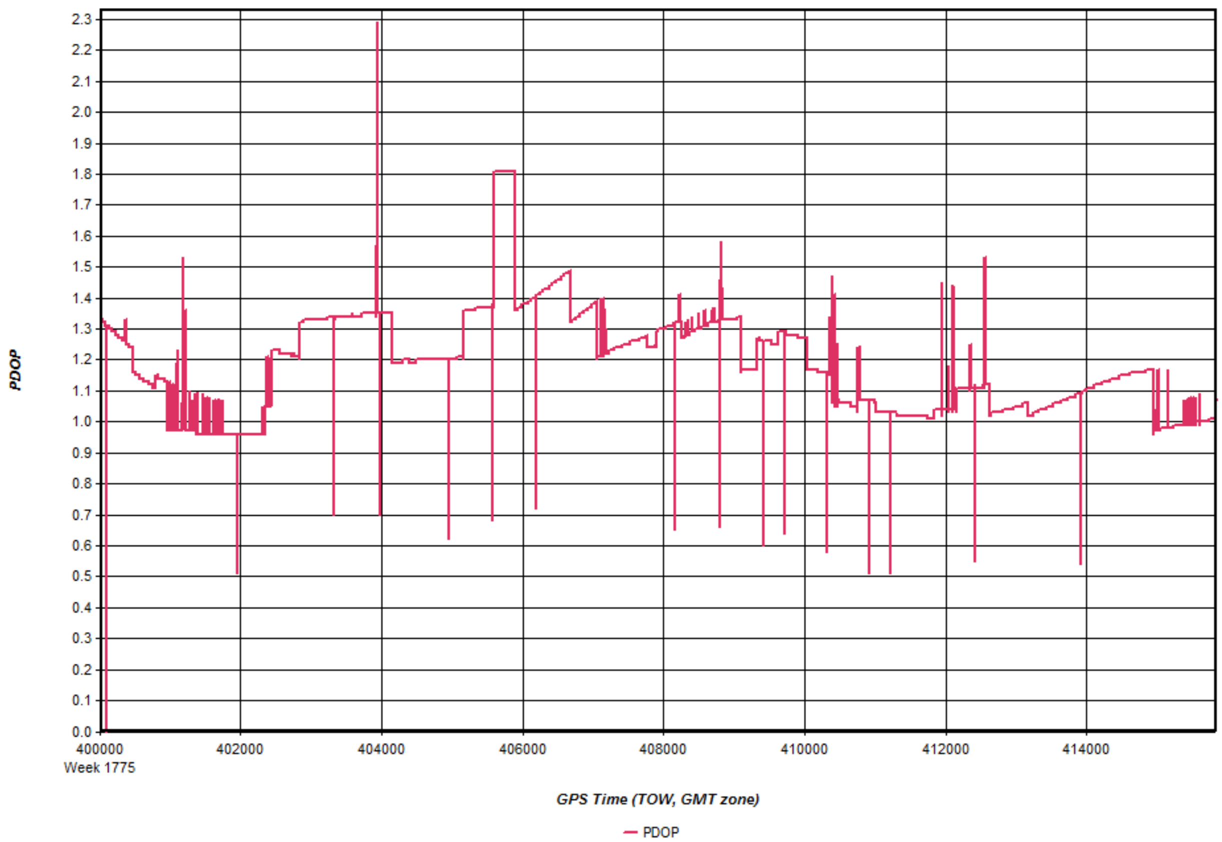

1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
PDOP
336000
Week 1775
336500
337000
337500
338000
338500
339000
339500
340000
340500
GPS Time (TOW, GMT zone)
PDOP


ALMJ
MOB
10 km

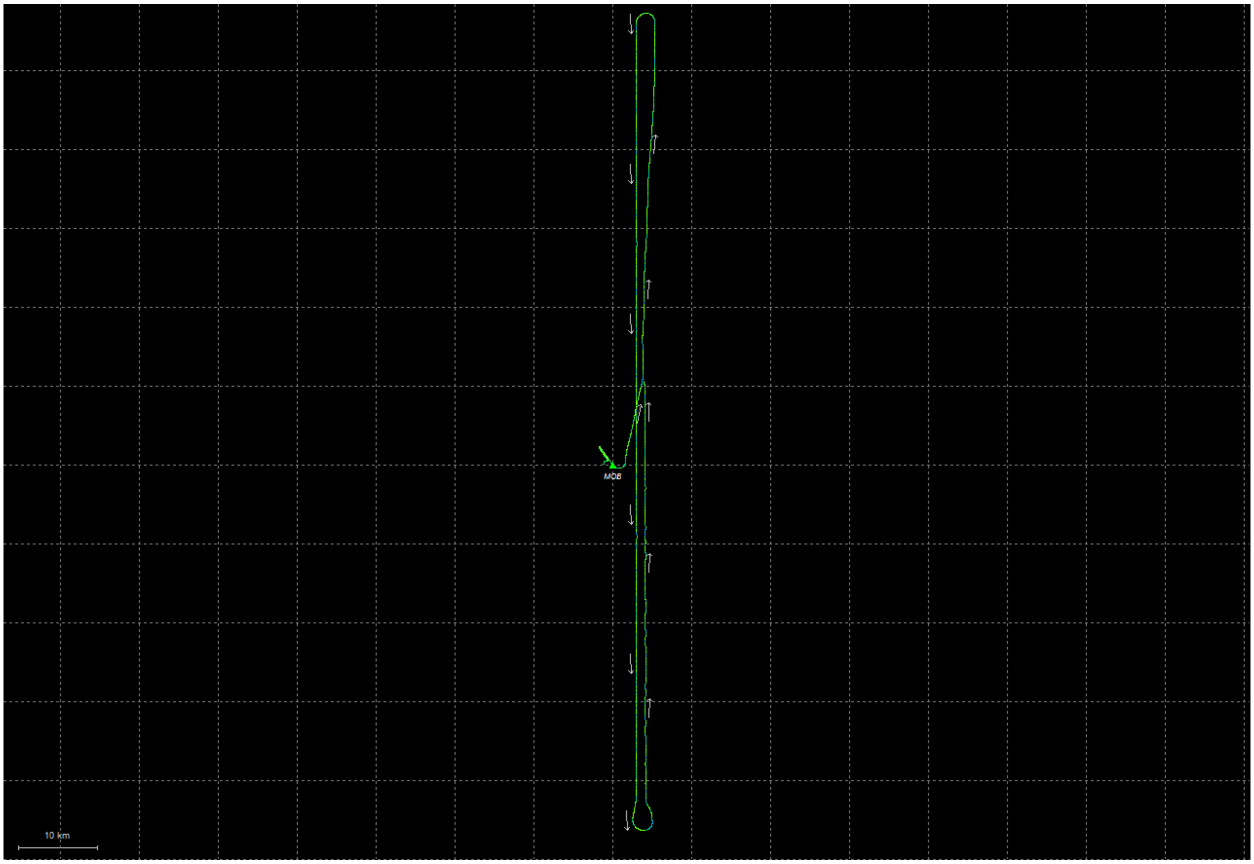

0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
Estimated StdDev (m)
400000
Week 1775
402000
404000
406000
408000
410000
412000
414000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

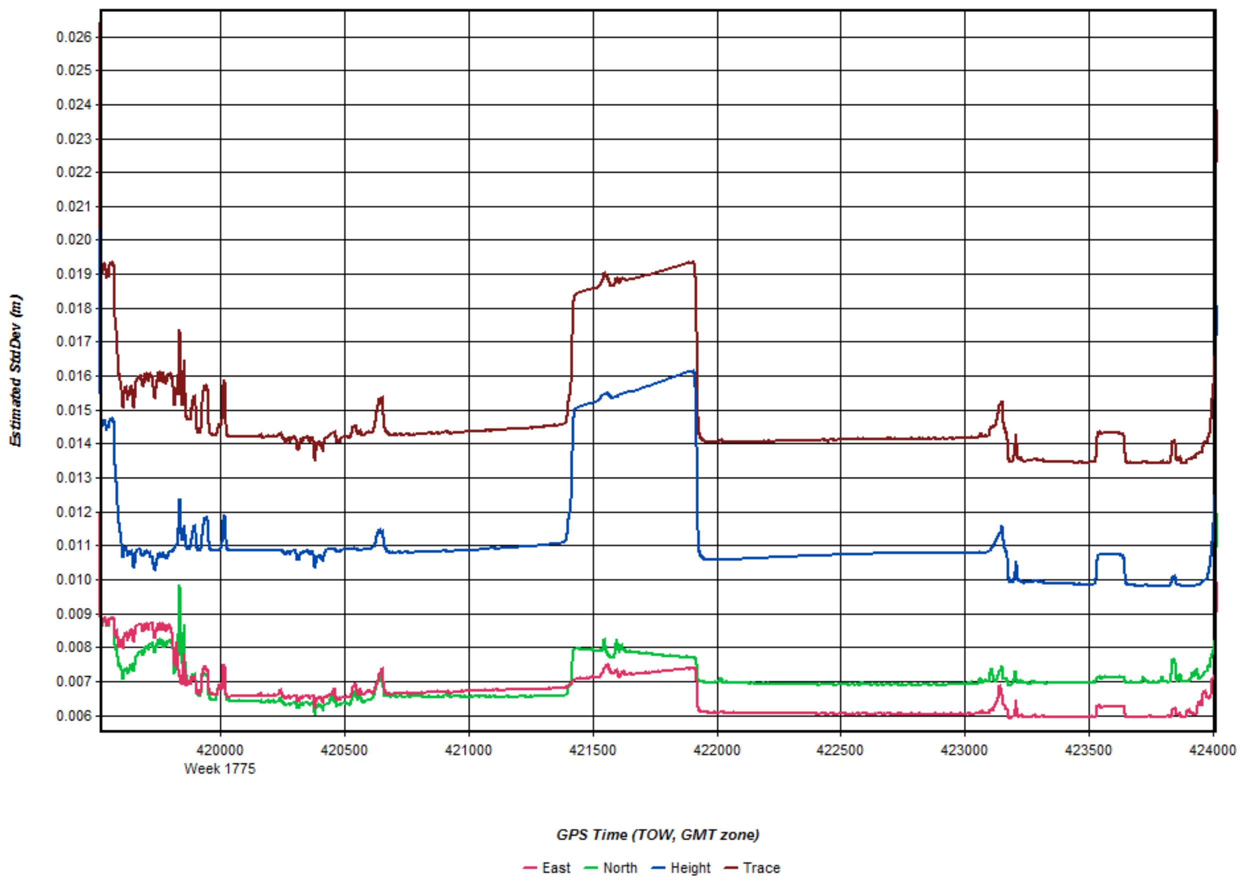

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
400000
Week 1775
402000
404000
406000
408000
410000
412000
414000
GPS Time (TOW, GMT zone)
Height

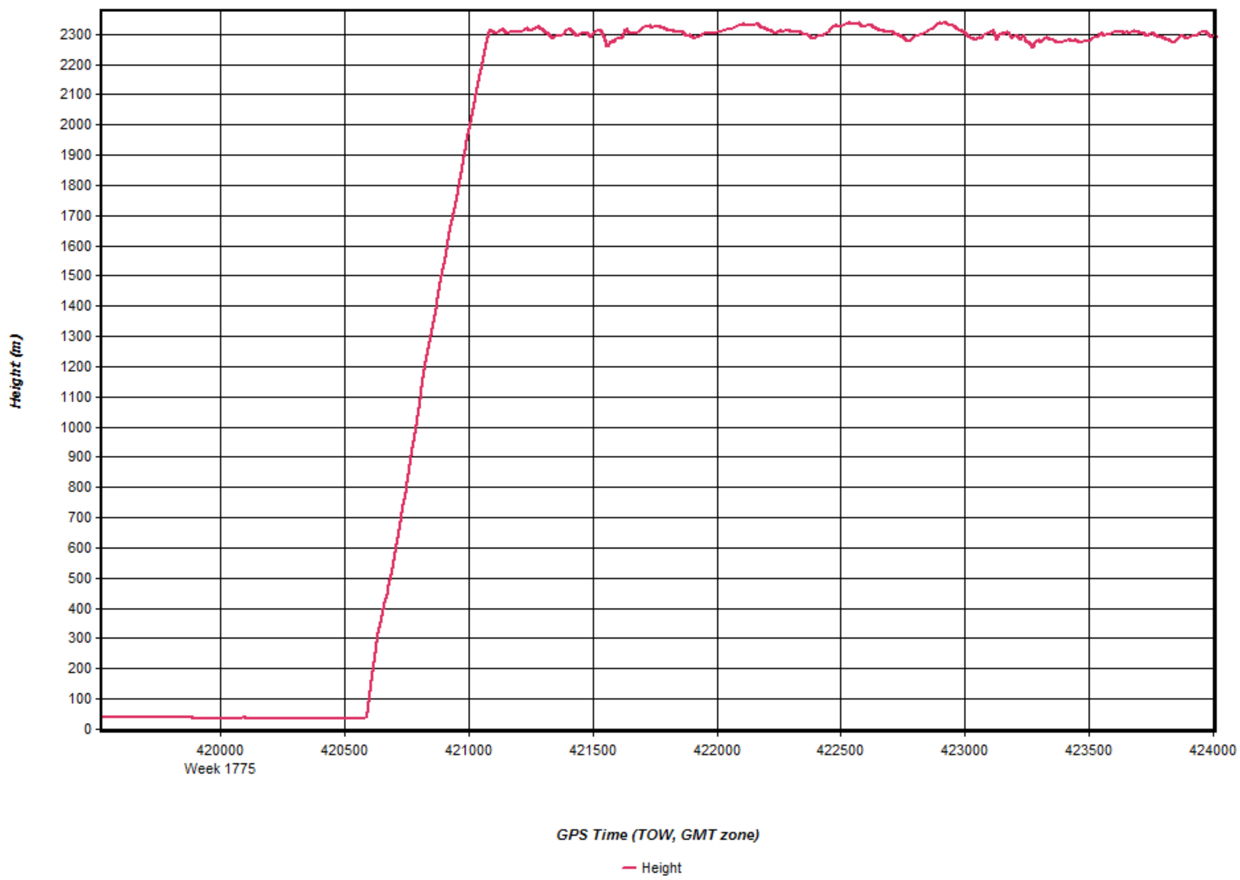

0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
Separation (m)
402000
Week 1775
404000
406000
408000
410000
412000
414000
GPS Time (TOW, GMT zone)
East
North
Up

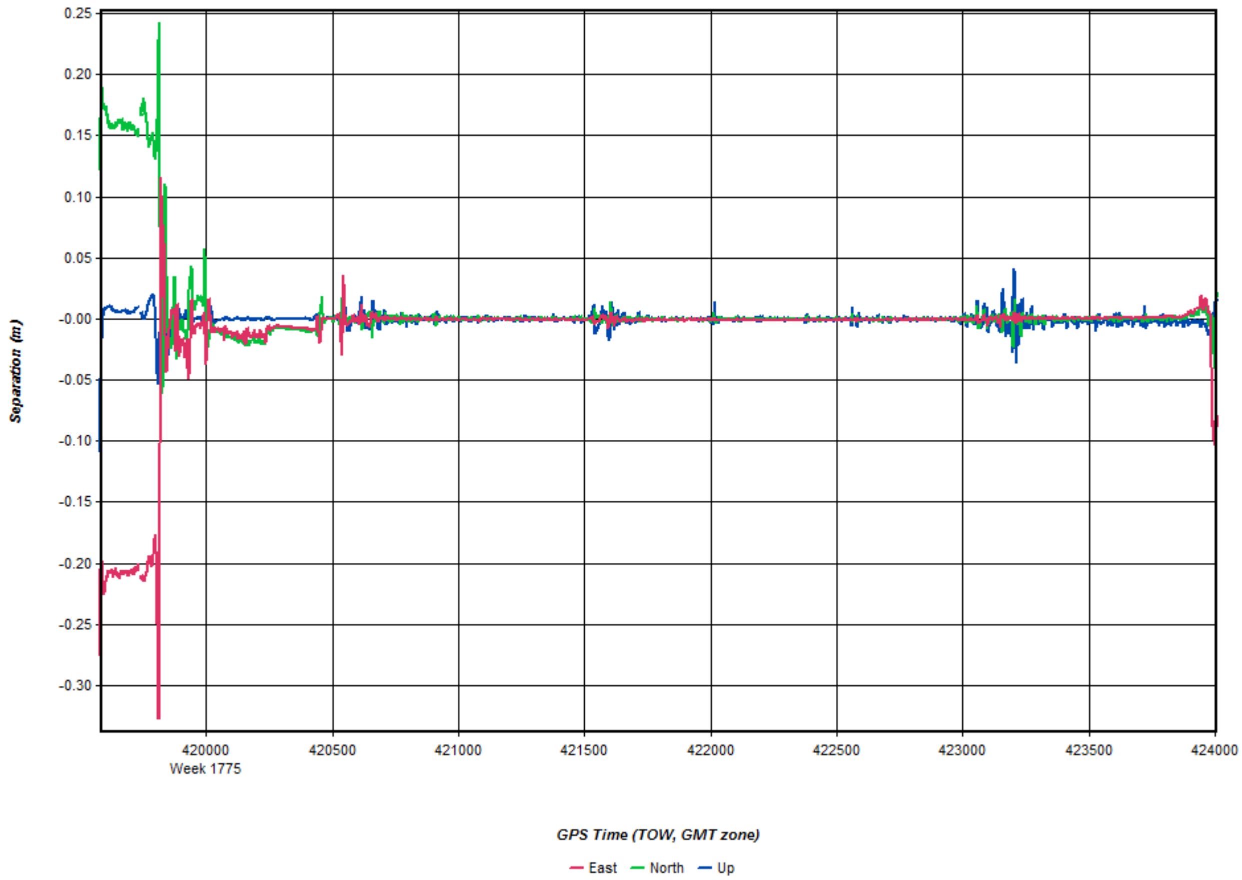

PDOP
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
400000
Week 1775
402000
404000
406000
408000
410000
412000
414000
GPS Time (TOW, GMT zone)
PDOP

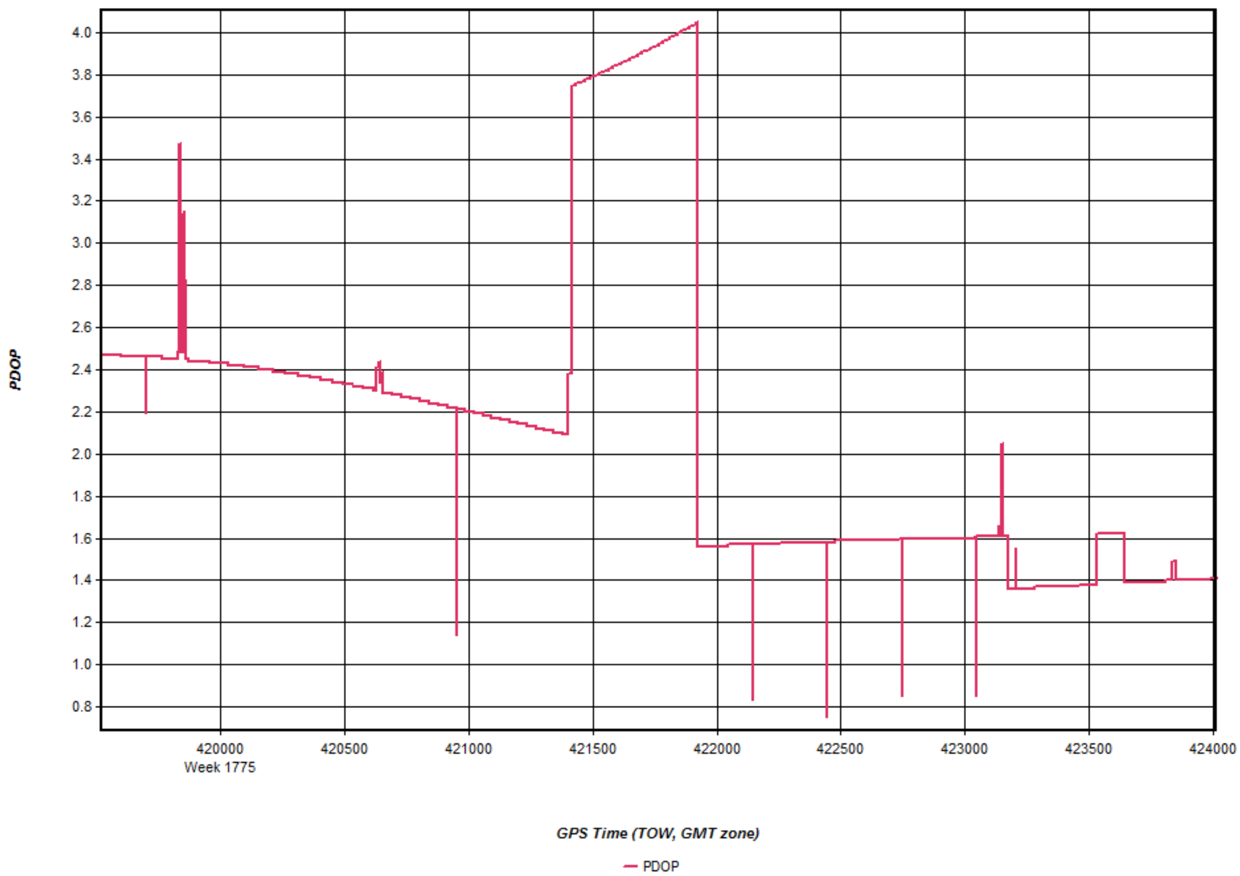
JD14016F02


MOB
10 km

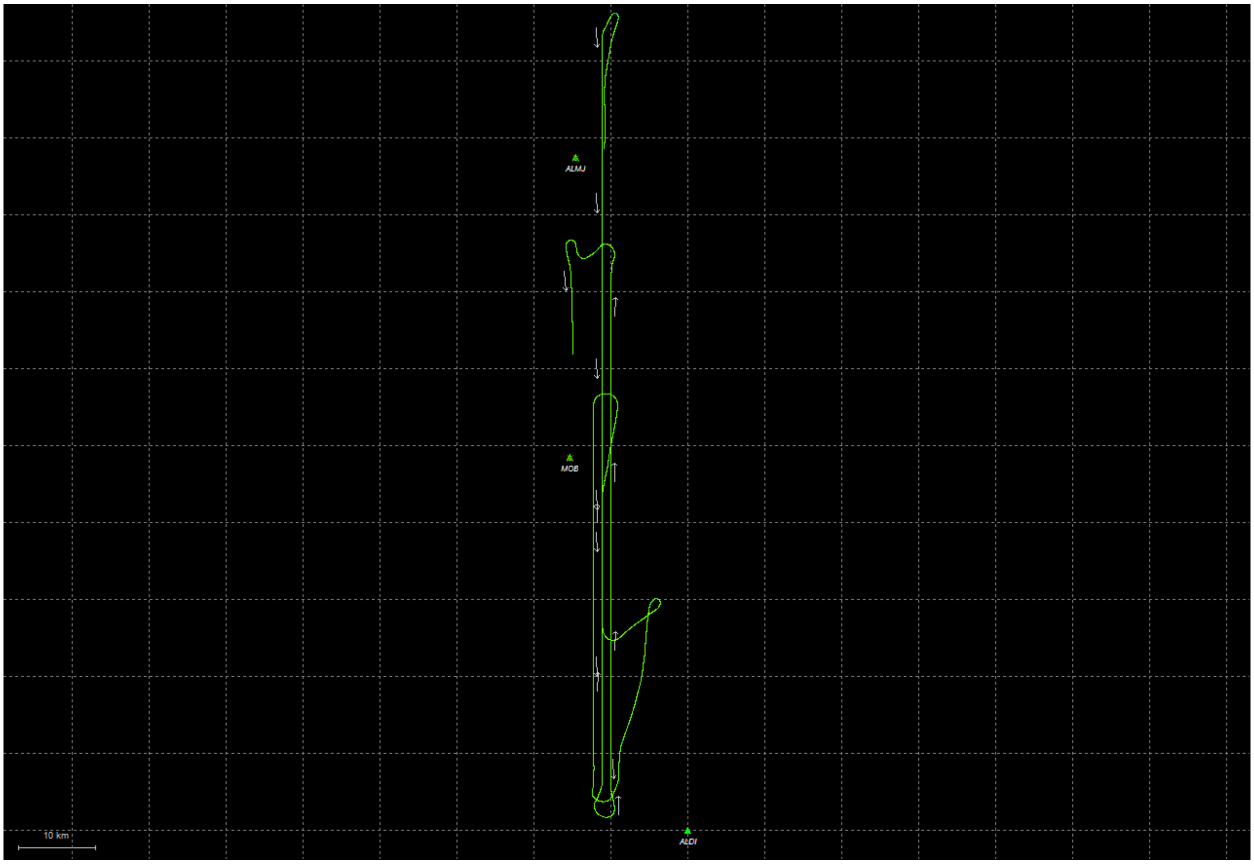

Estimated StdDev (m)
0.026
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
420000
Week 1775
420500
421000
421500
422000
422500
423000
423500
424000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

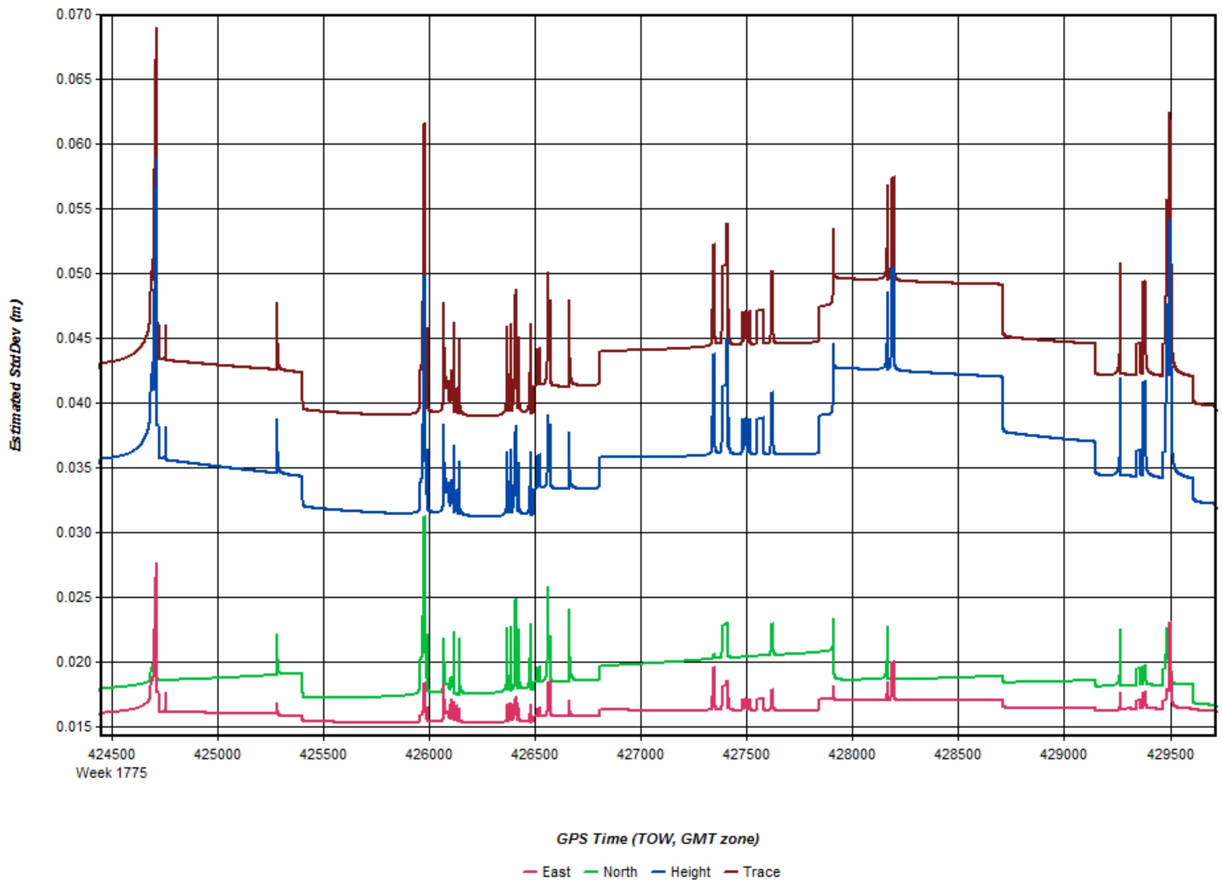

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
420000
Week 1775
420500
421000
421500
422000
422500
423000
423500
424000
GPS Time (TOW, GMT zone)
Height

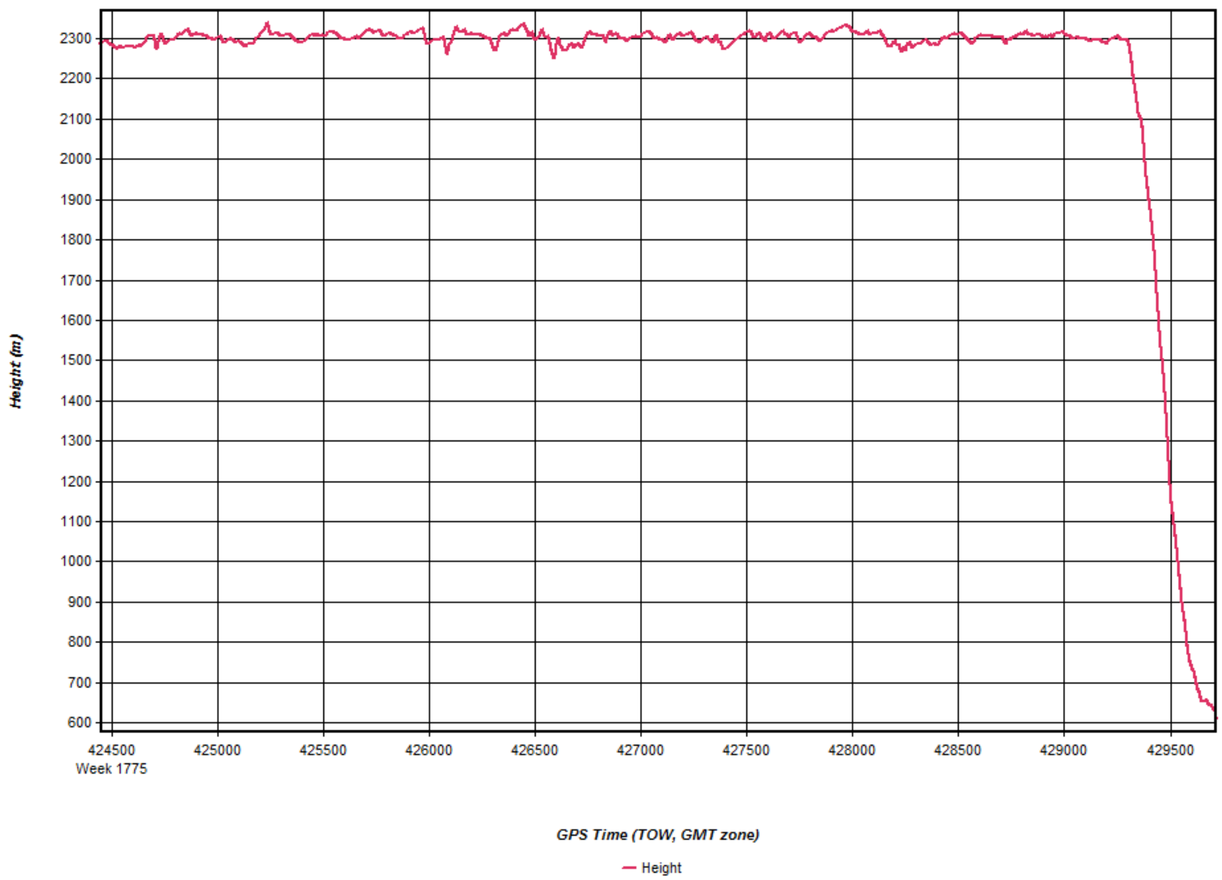

0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
Separation (m)
420000
Week 1775
420500
421000
421500
422000
422500
423000
423500
424000
GPS Time (TOW, GMT zone)
East
North
Up

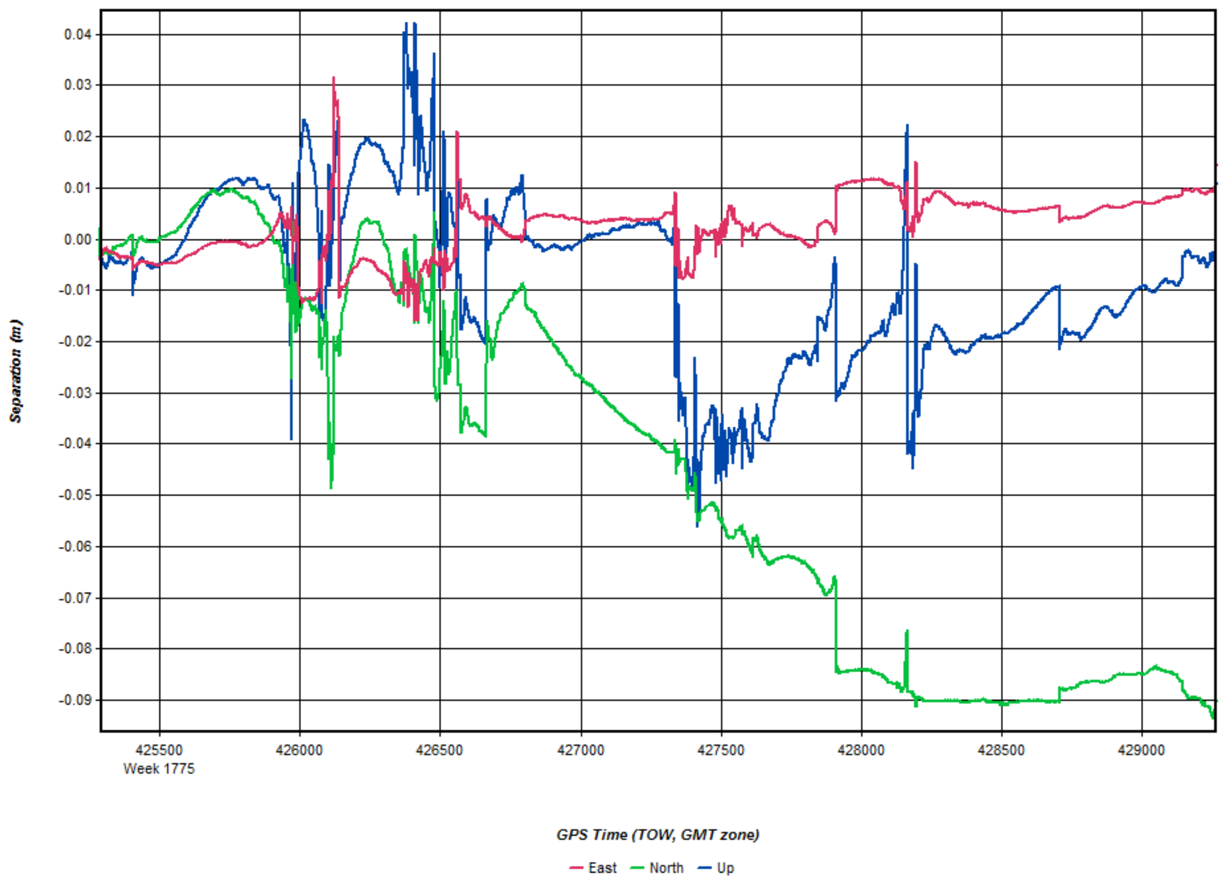


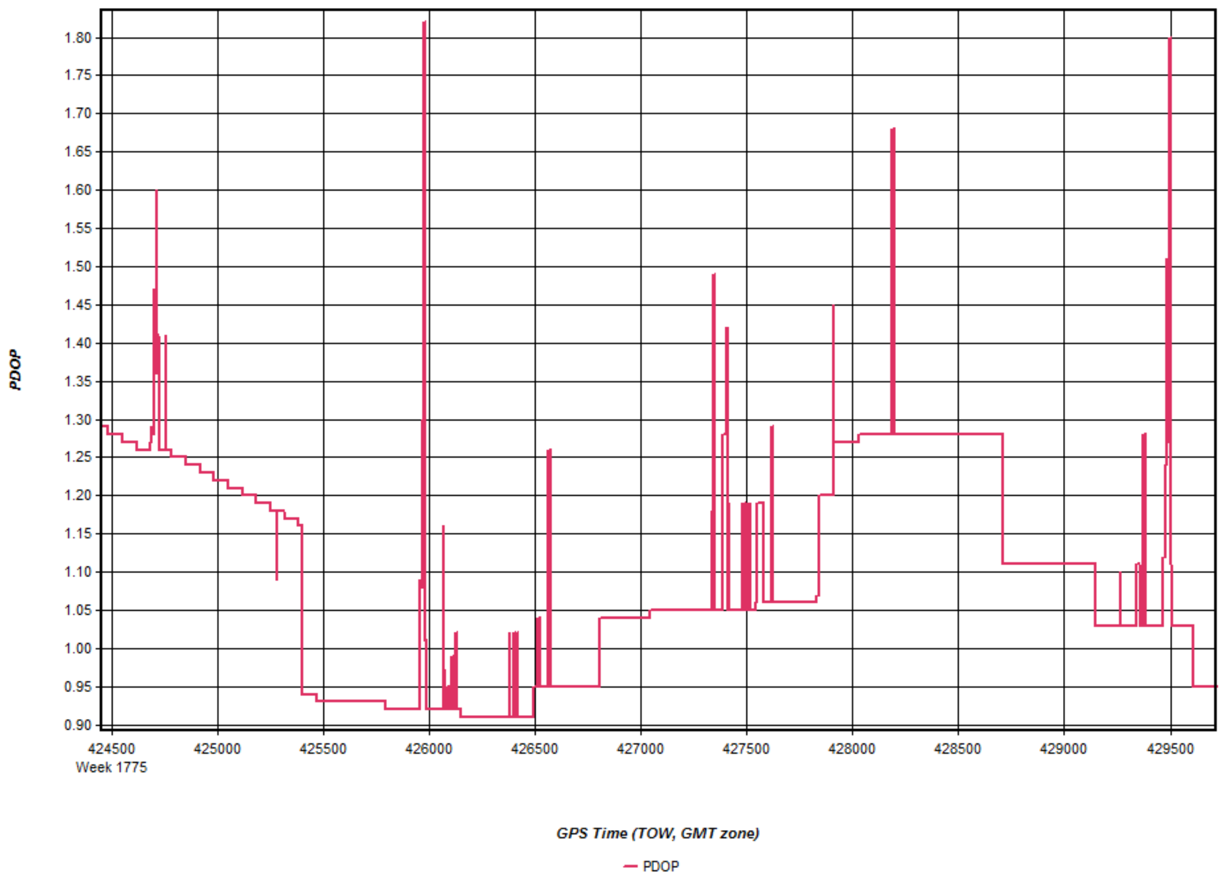
JD14016F02b (processed separately due to PDOP)

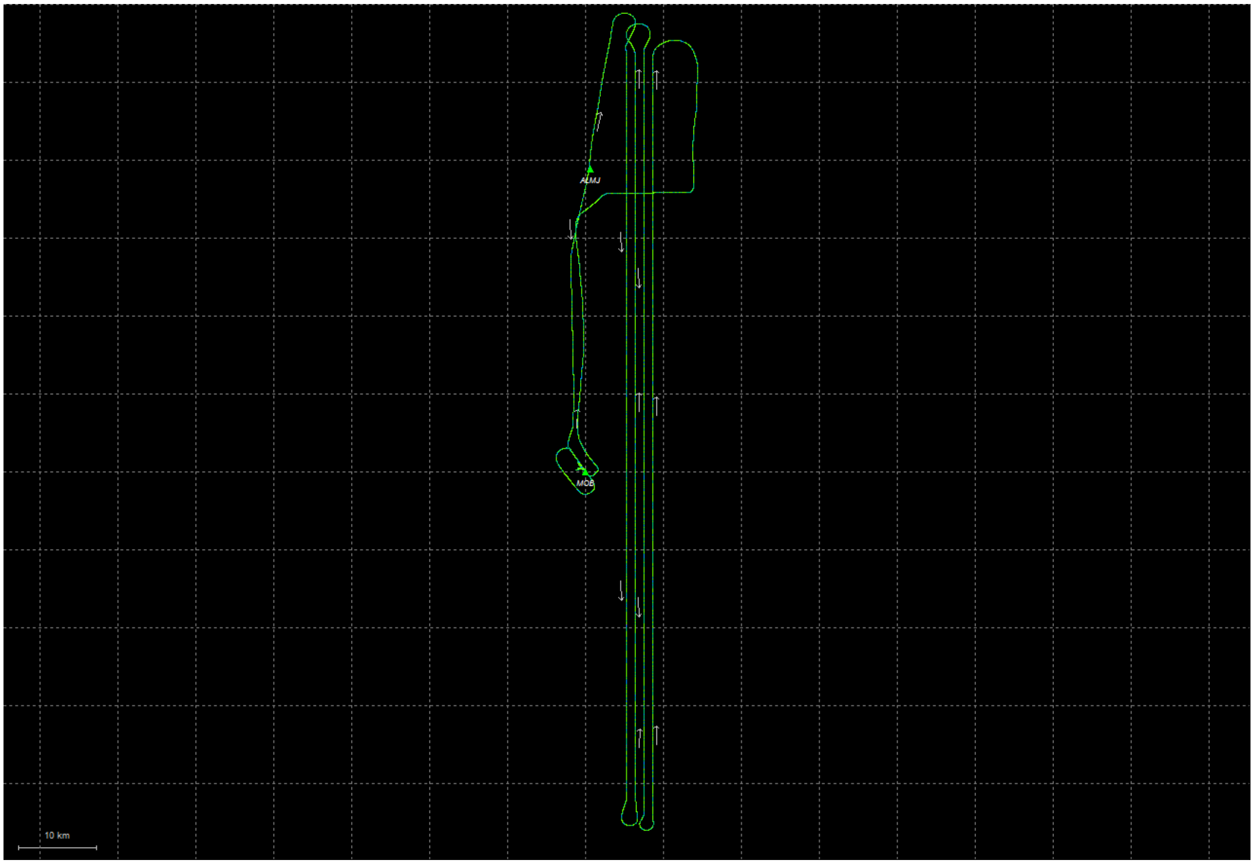

ALMJ
MOB
ALDI
10 km

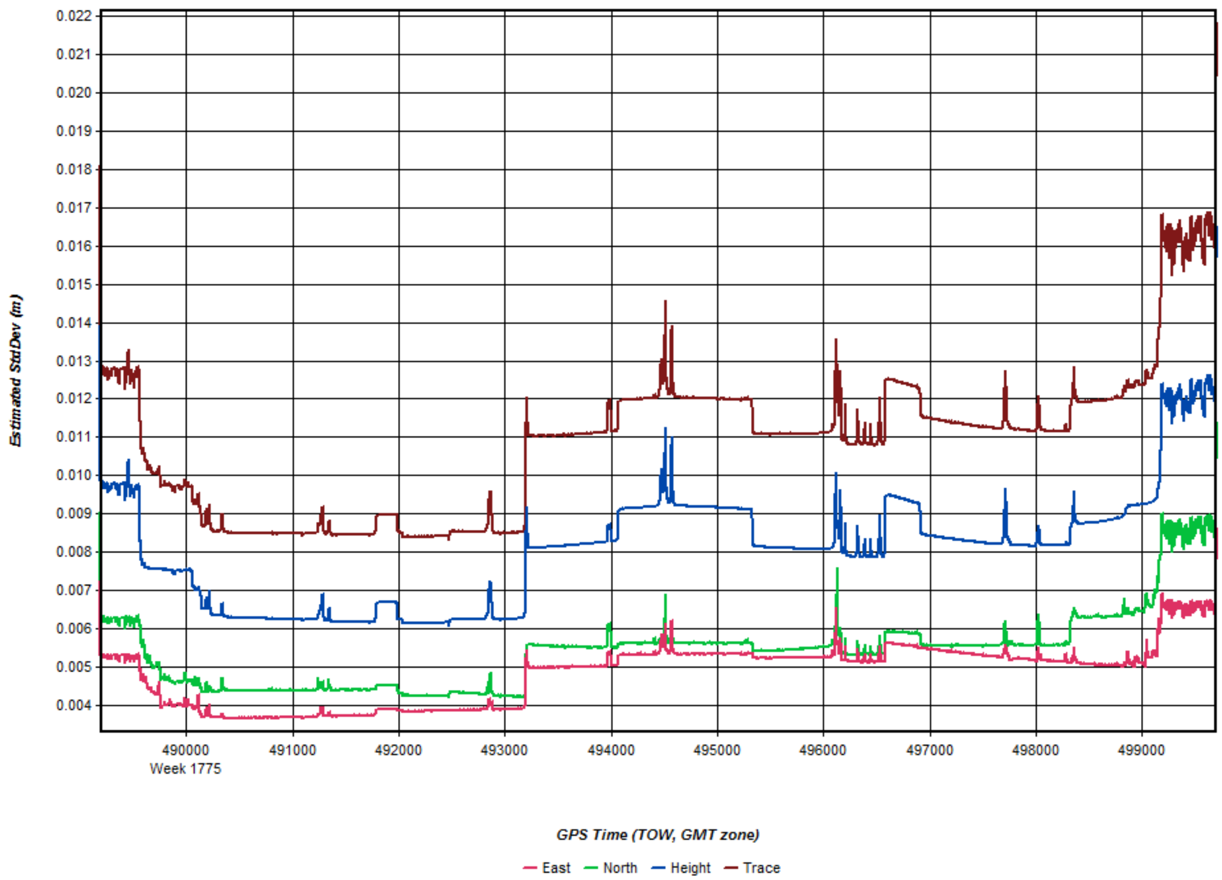

0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
Estimated StdDev (m)
424500
Week 1775
425000
425500
426000
426500
427000
427500
428000
428500
429000
429500
GPS Time (TOW, GMT zone)
East
North
Height
Trace

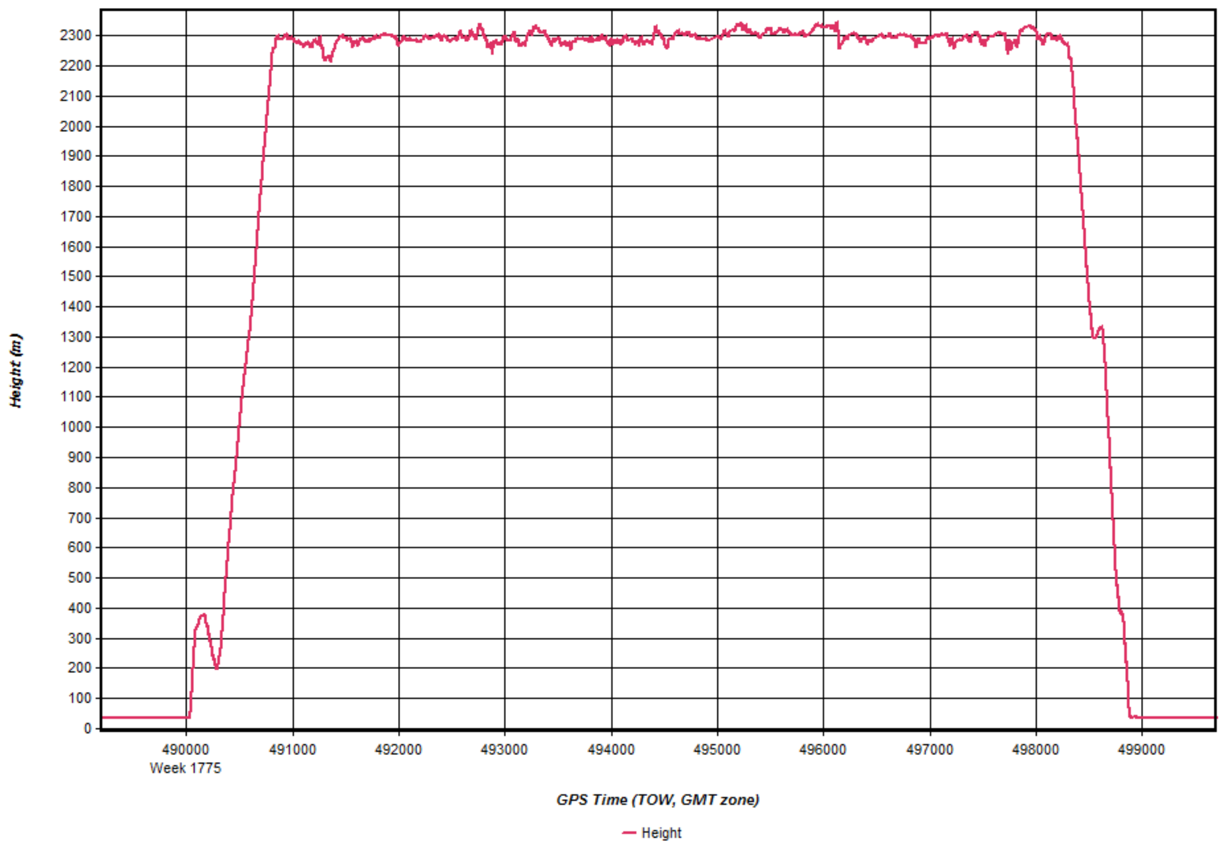

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
424500
Week 1775
425000
425500
426000
426500
427000
427500
428000
428500
429000
429500
GPS Time (TOW, GMT zone)
Height

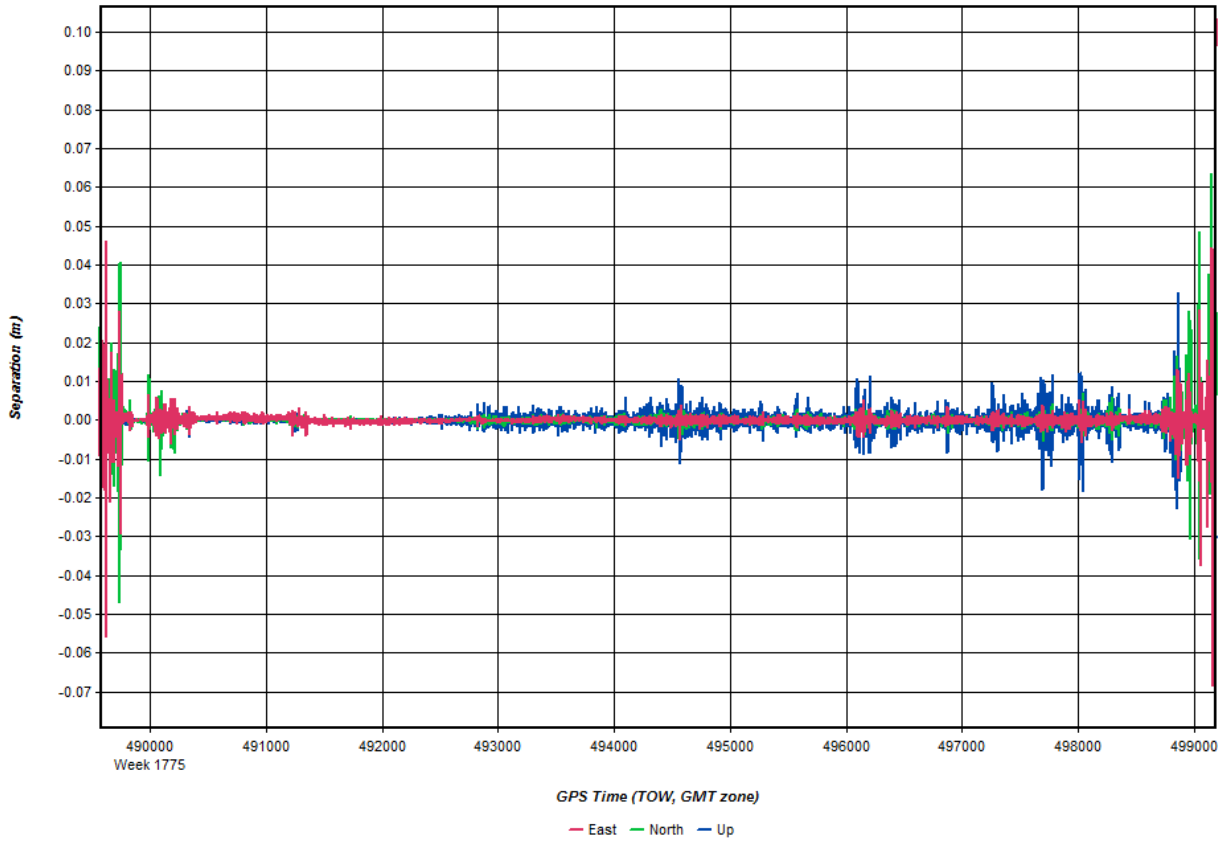

0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
Separation (m)
425500
Week 1775
426000
426500
427000
427500
428000
428500
429000
GPS Time (TOW, GMT zone)
East
North
Up

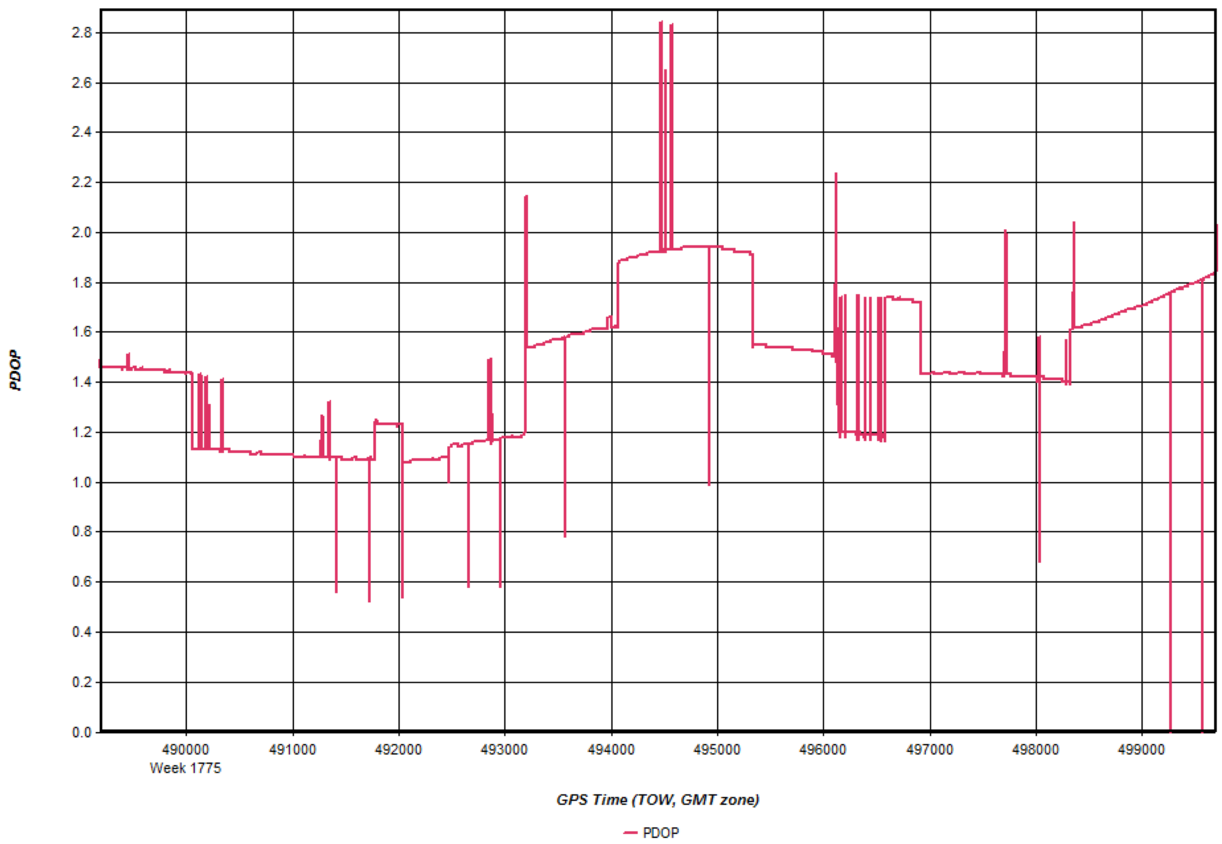

PDOP
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
424500
Week 1775
425000
425500
426000
426500
427000
427500
428000
428500
429000
429500
GPS Time (TOW, GMT zone)
PDOP


ALMJ
MOB
10 km


0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
Estimated StdDev (m)
490000
Week 1775
491000
492000
493000
494000
495000
496000
497000
498000
499000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

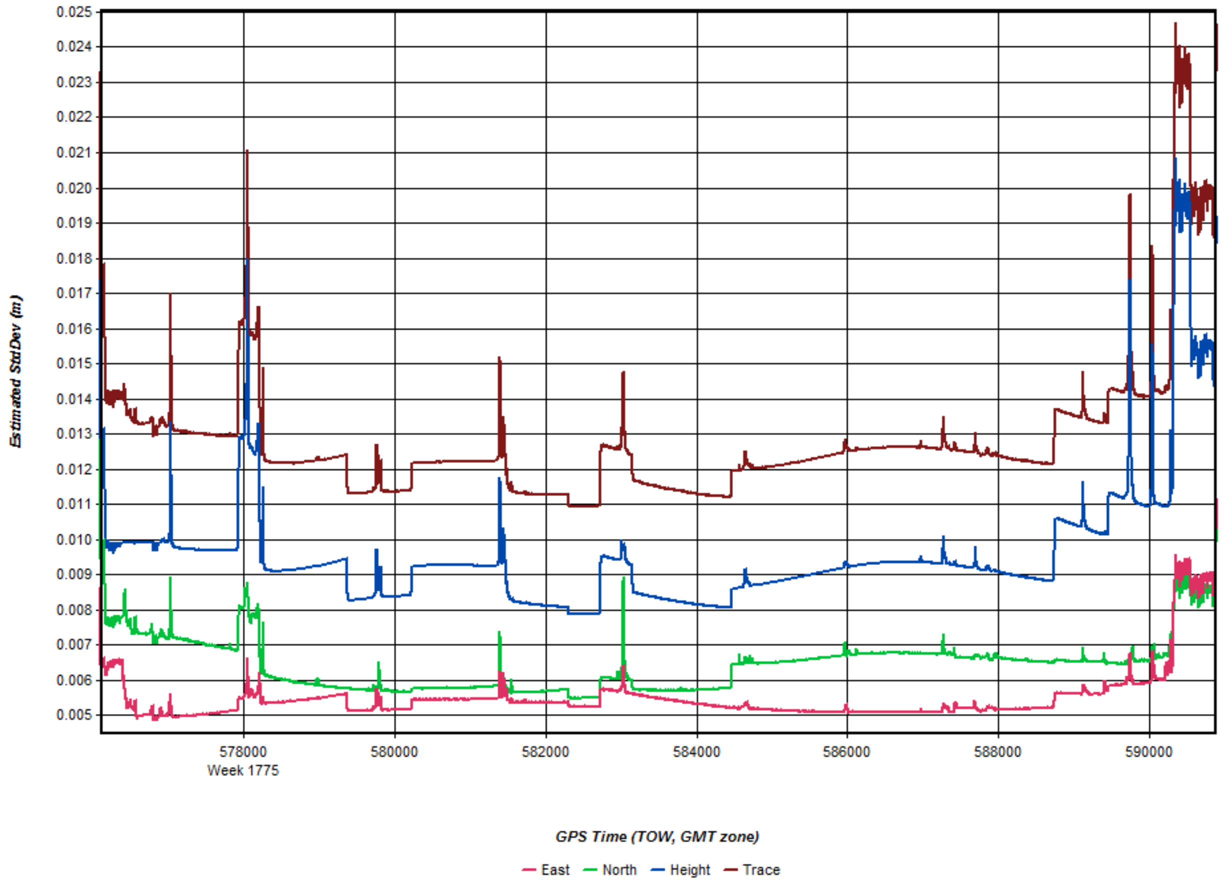

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
490000
Week 1775
491000
492000
493000
494000
495000
496000
497000
498000
499000
GPS Time (TOW, GMT zone)
Height

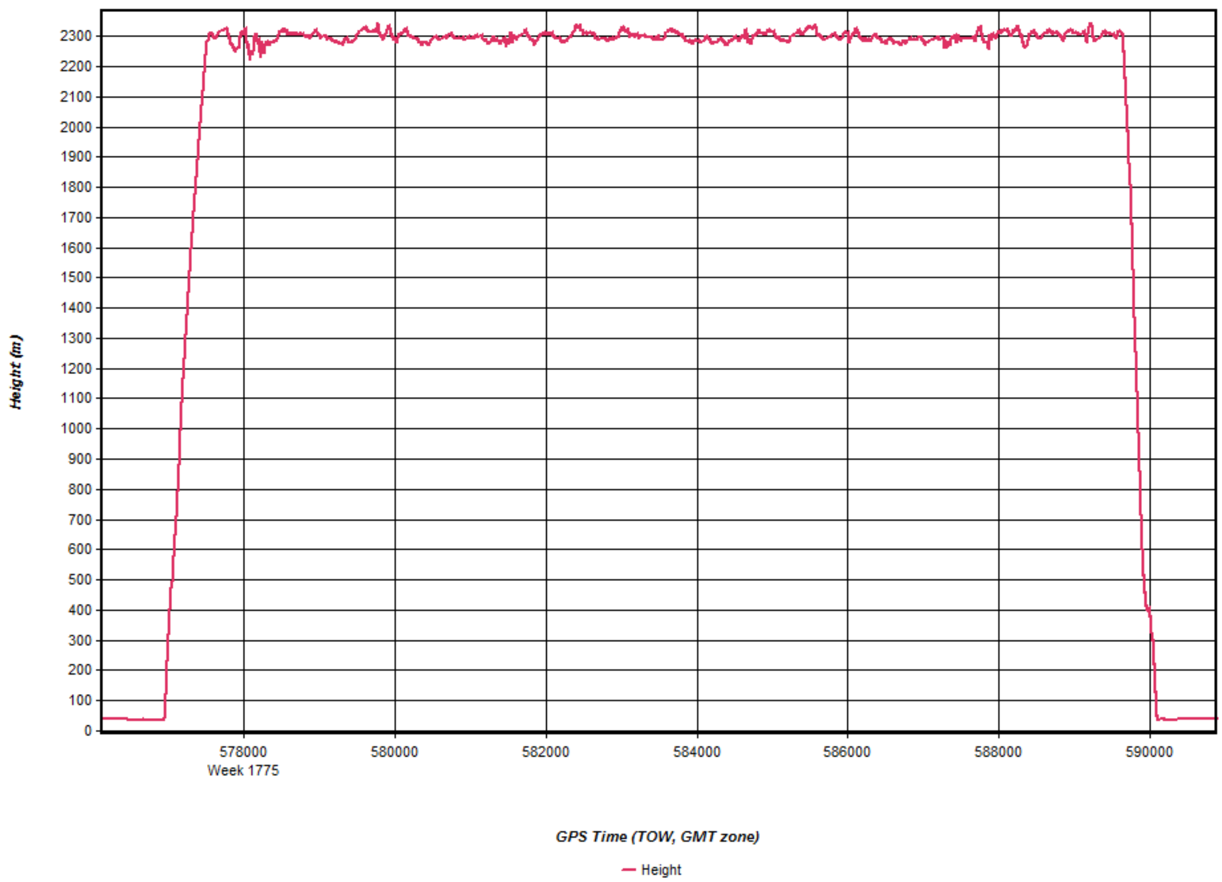

0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
Separation (m)
490000
Week 1775
491000
492000
493000
494000
495000
496000
497000
498000
499000
GPS Time (TOW, GMT zone)
East
North
Up

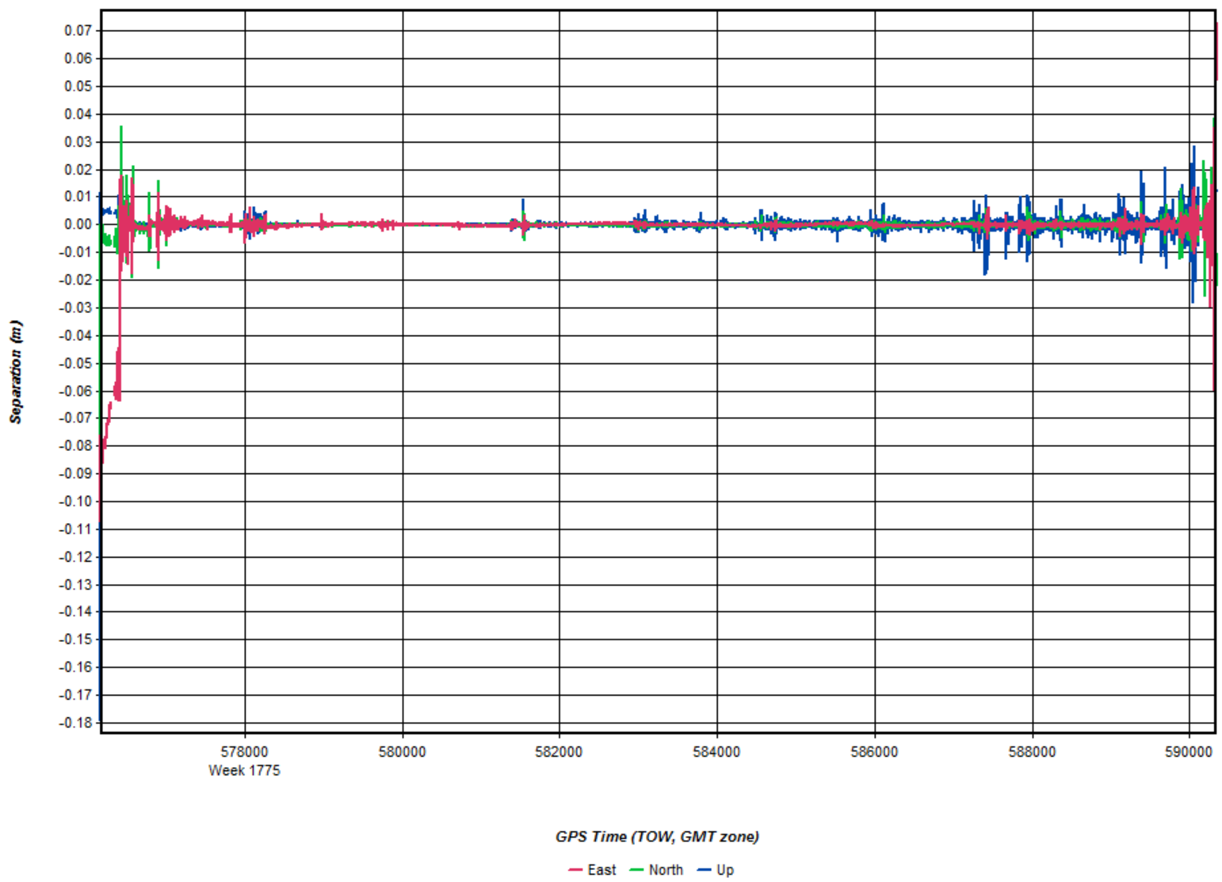

PDOP
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
490000
Week 1775
491000
492000
493000
494000
495000
496000
497000
498000
499000
GPS Time (TOW, GMT zone)
PDOP

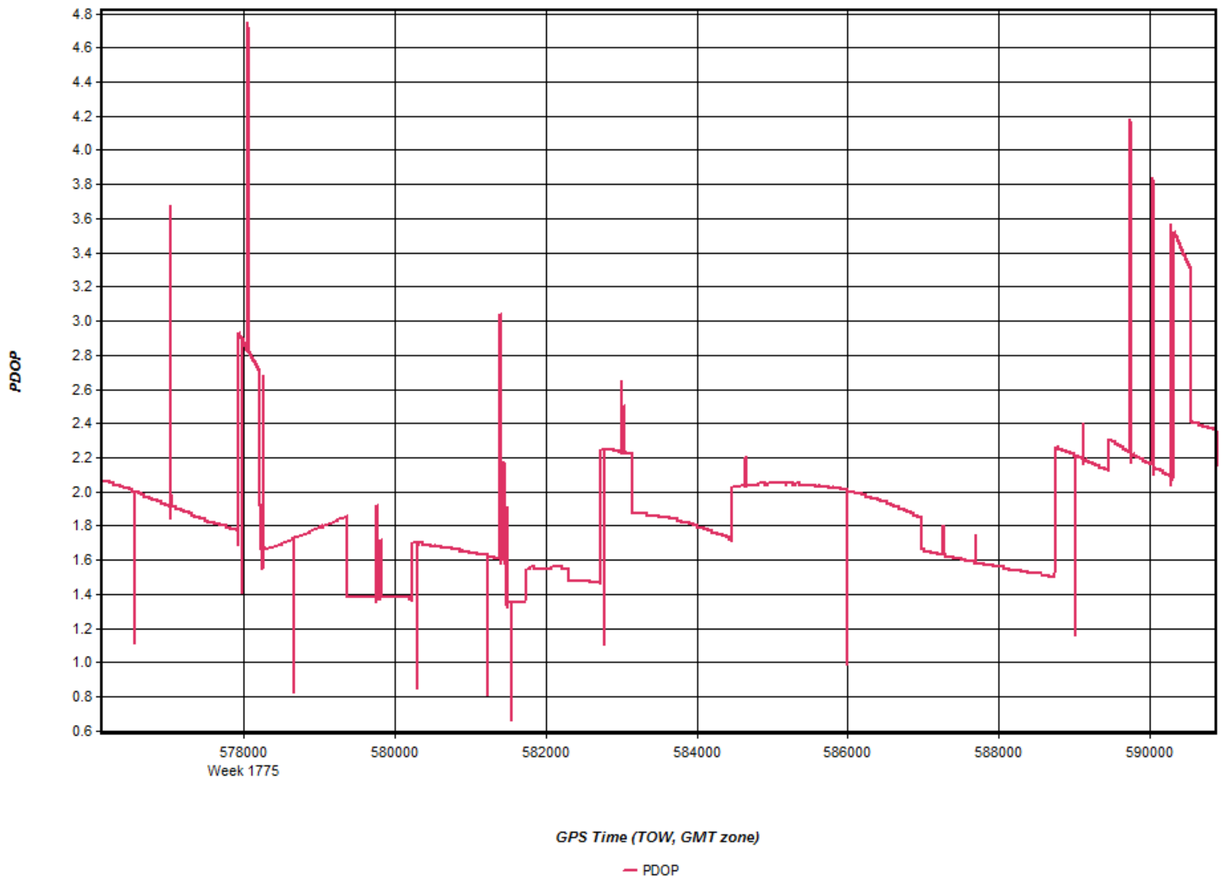
JD14018F01

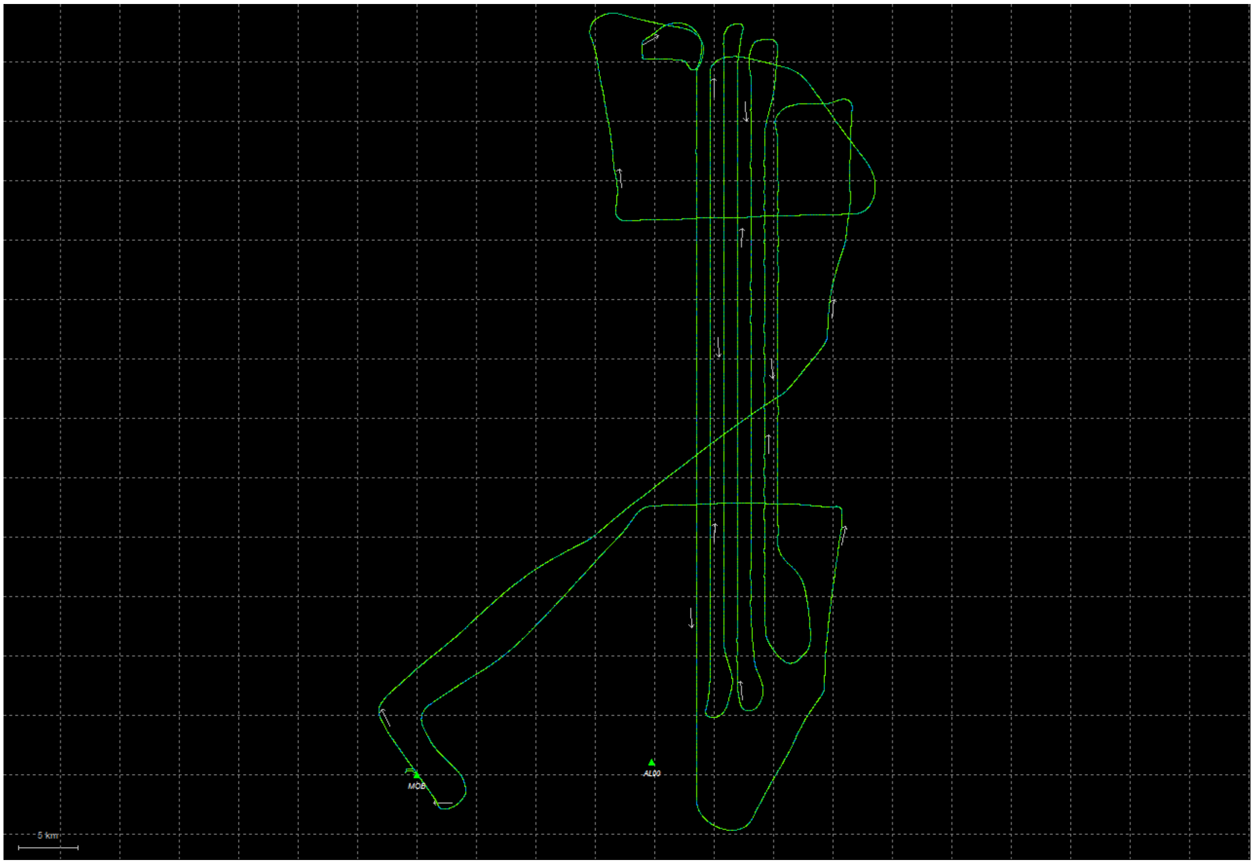

10 km

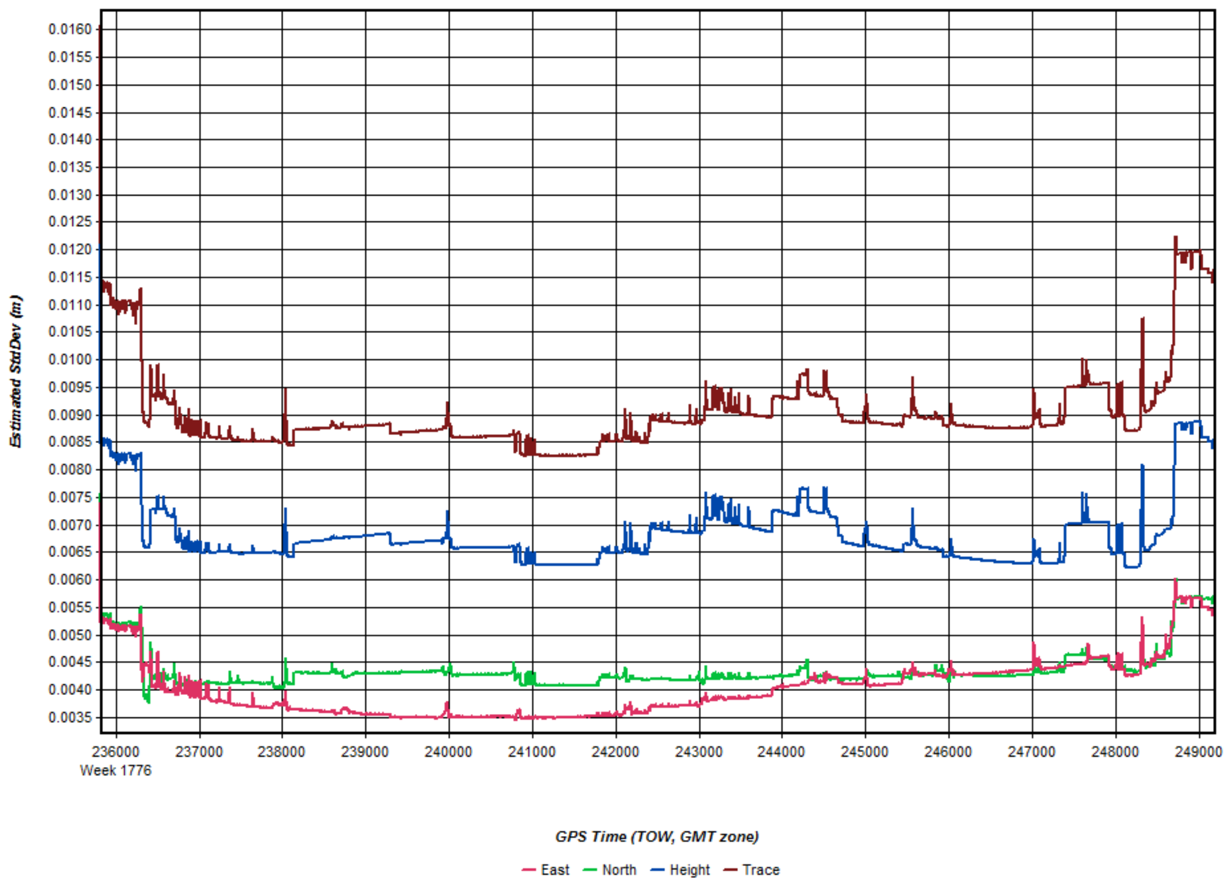

Estimated StdDev (m)
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
578000
Week 1775
580000
582000
584000
586000
588000
590000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

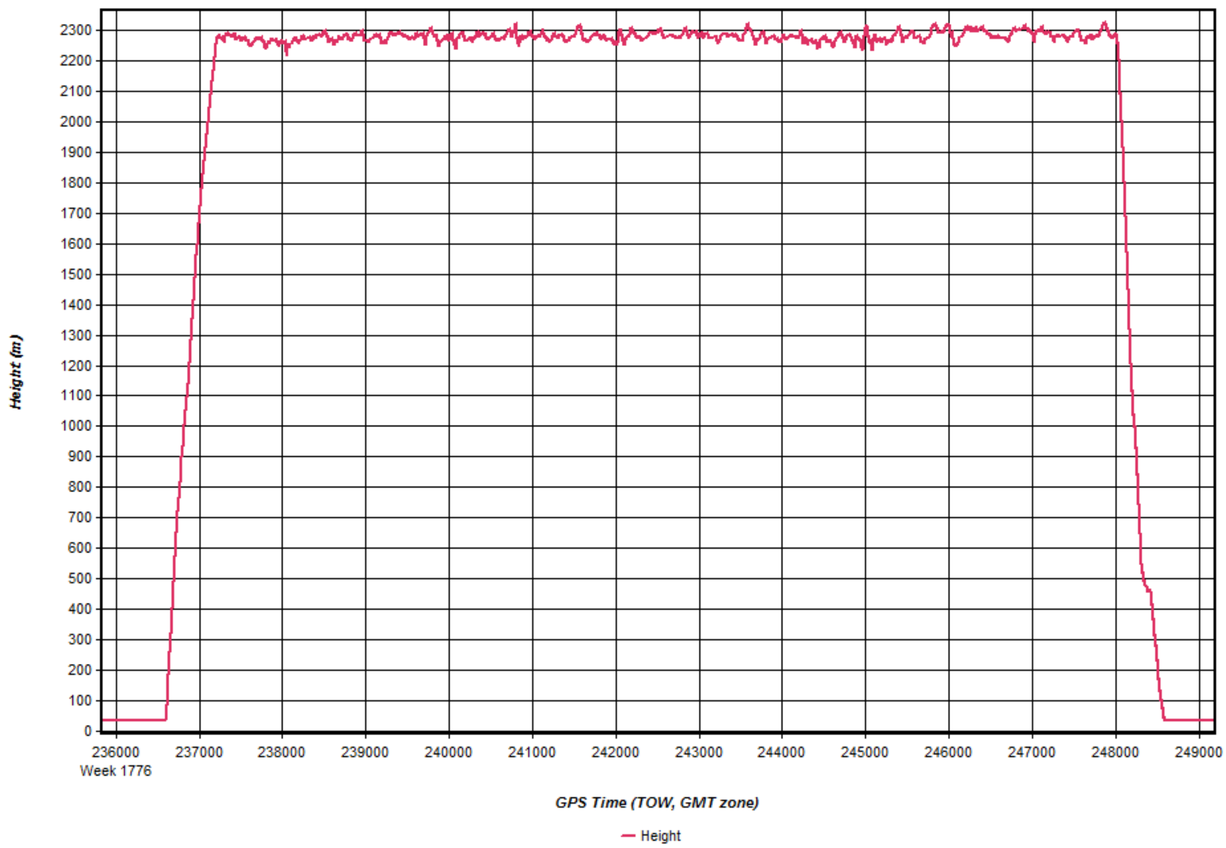

2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Height (m)
578000
Week 1775
580000
582000
584000
586000
588000
590000
GPS Time (TOW, GMT zone)
Height

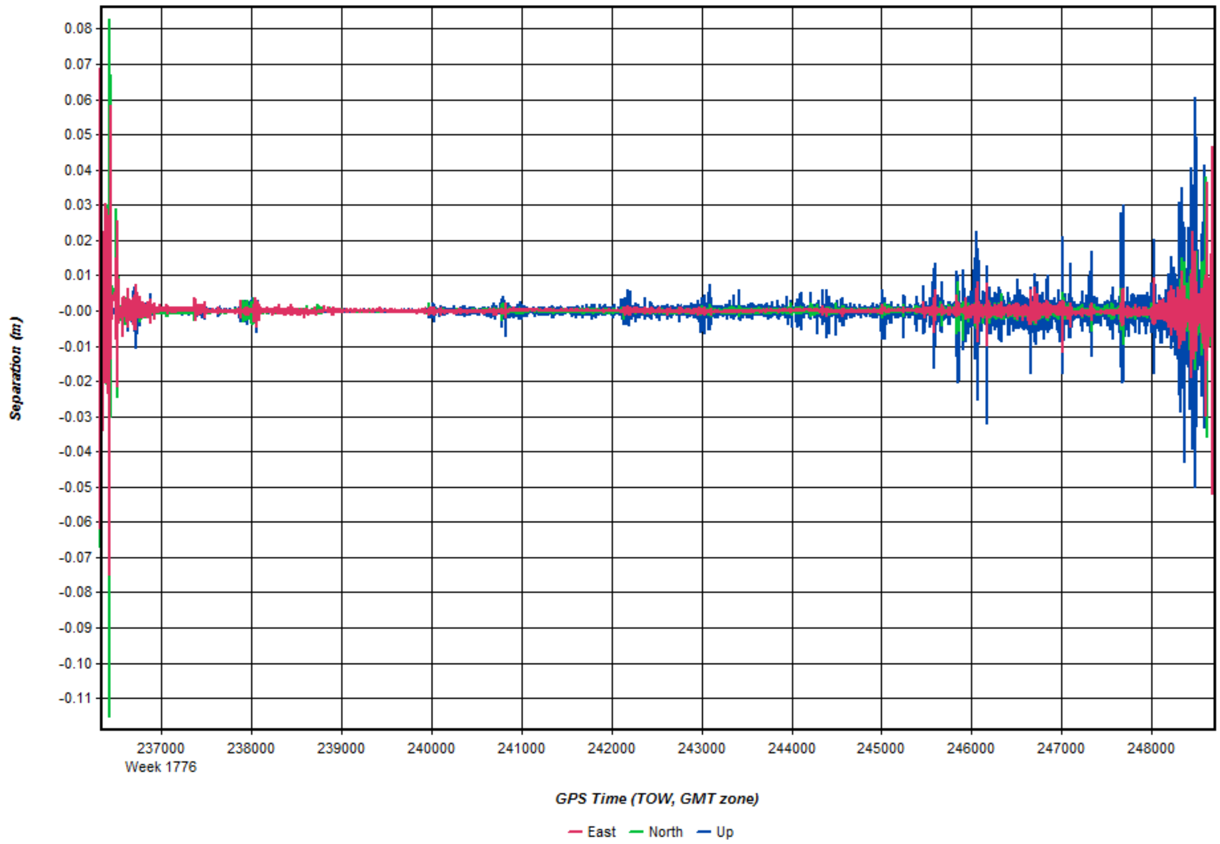

Separation (m)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
578000
Week 1775
580000
582000
584000
586000
588000
590000
GPS Time (TOW, GMT zone)
East
North
Up

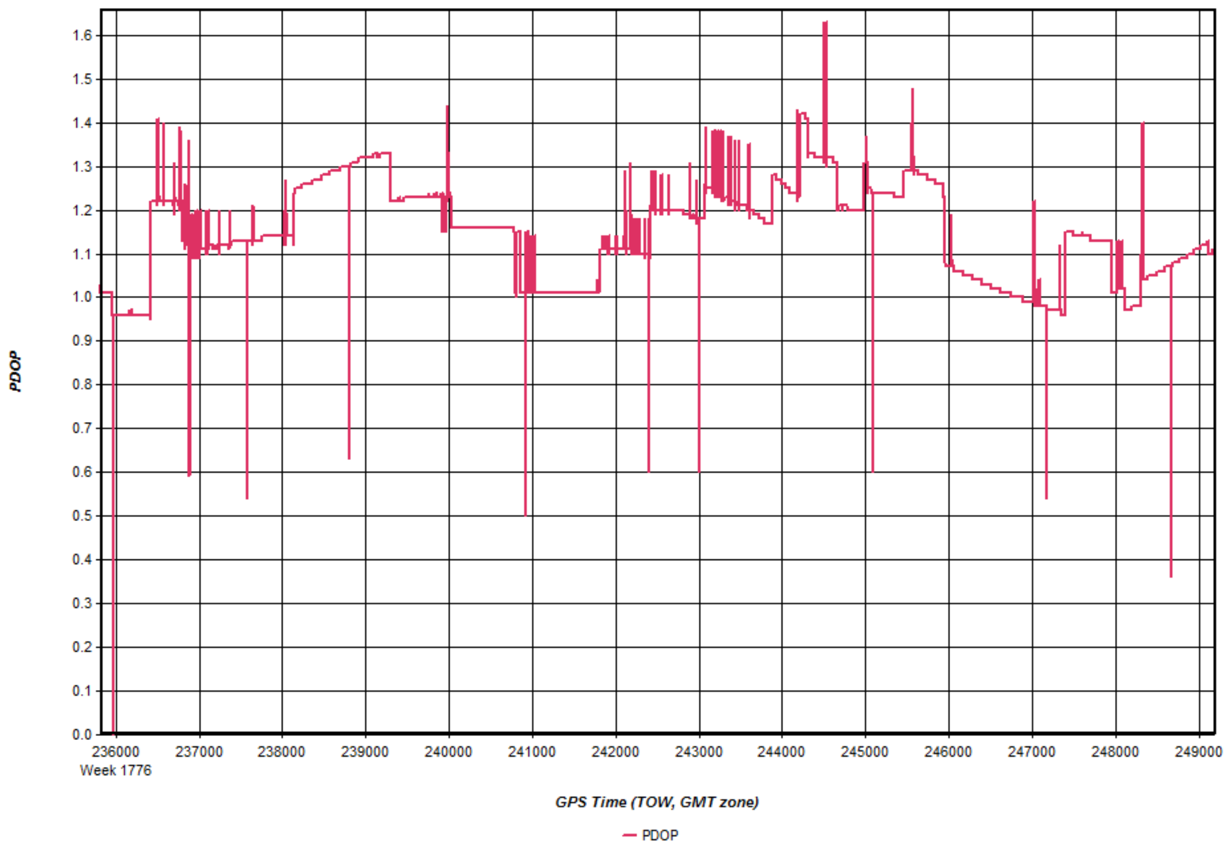

PDOP
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
578000
Week 1775
580000
582000
584000
586000
588000
590000
GPS Time (TOW, GMT zone)
PDOP



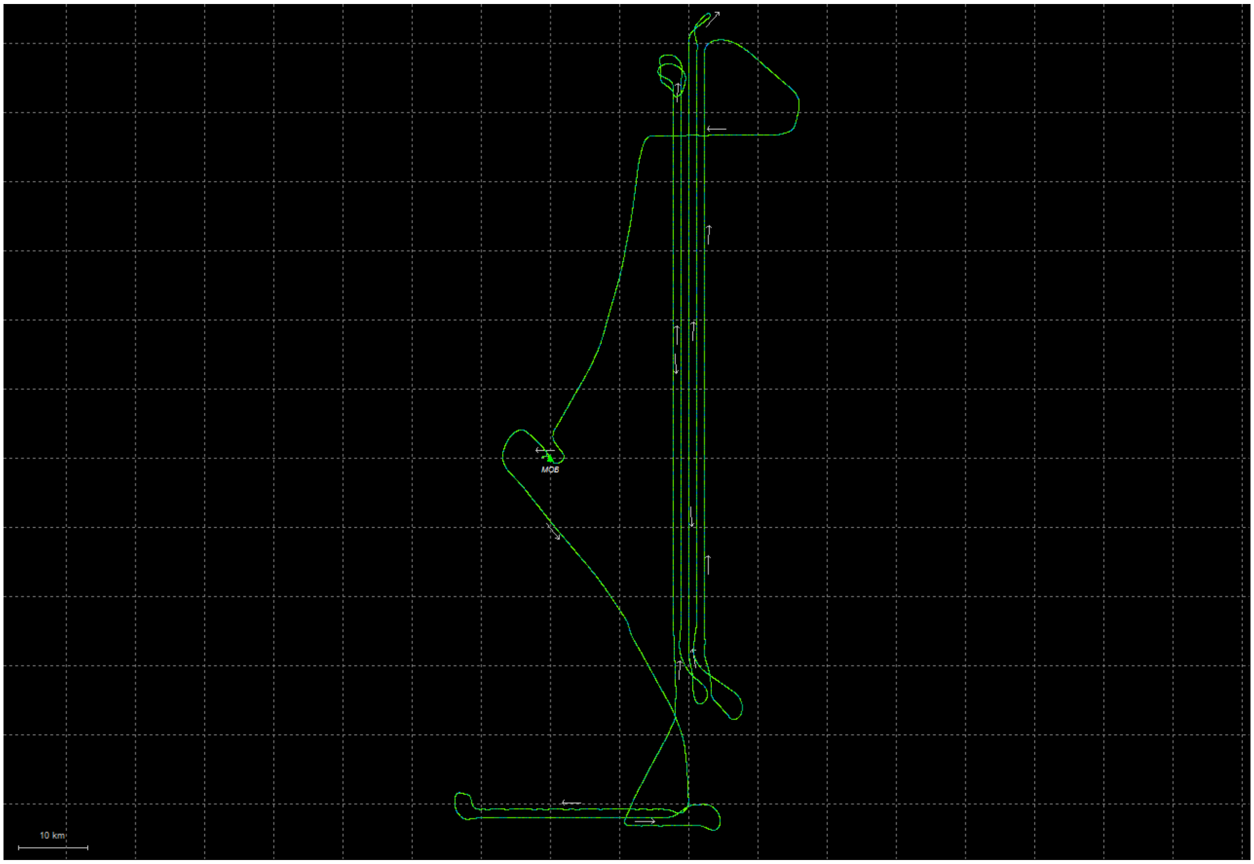

0.0160
0.0155
0.0150
0.0145
0.0140
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
Estimated StdDev (m)
236000
Week 1776
237000
238000
239000
240000
241000
242000
243000
244000
245000
246000
247000
248000
249000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

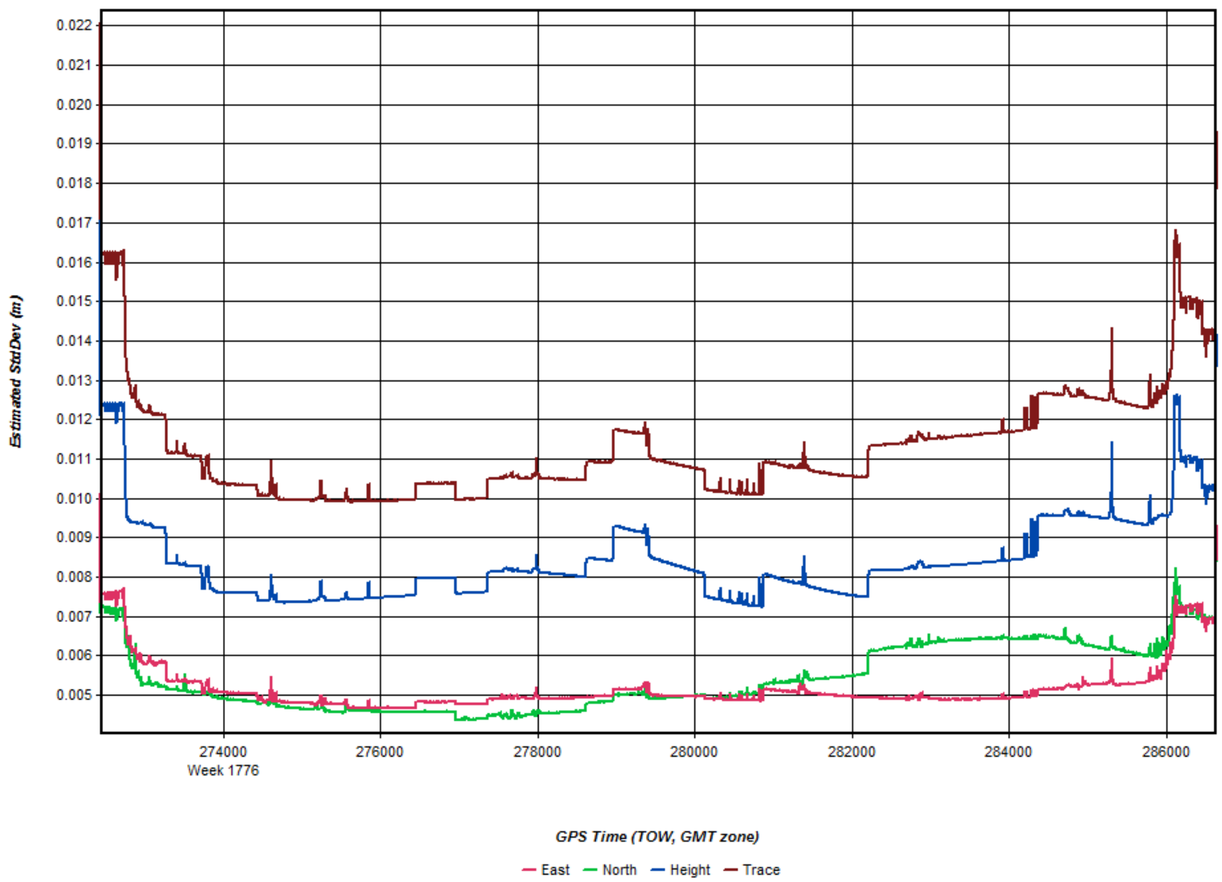

Height (m)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
236000
Week 1776
237000
238000
239000
240000
241000
242000
243000
244000
245000
246000
247000
248000
249000
GPS Time (TOW, GMT zone)
Height

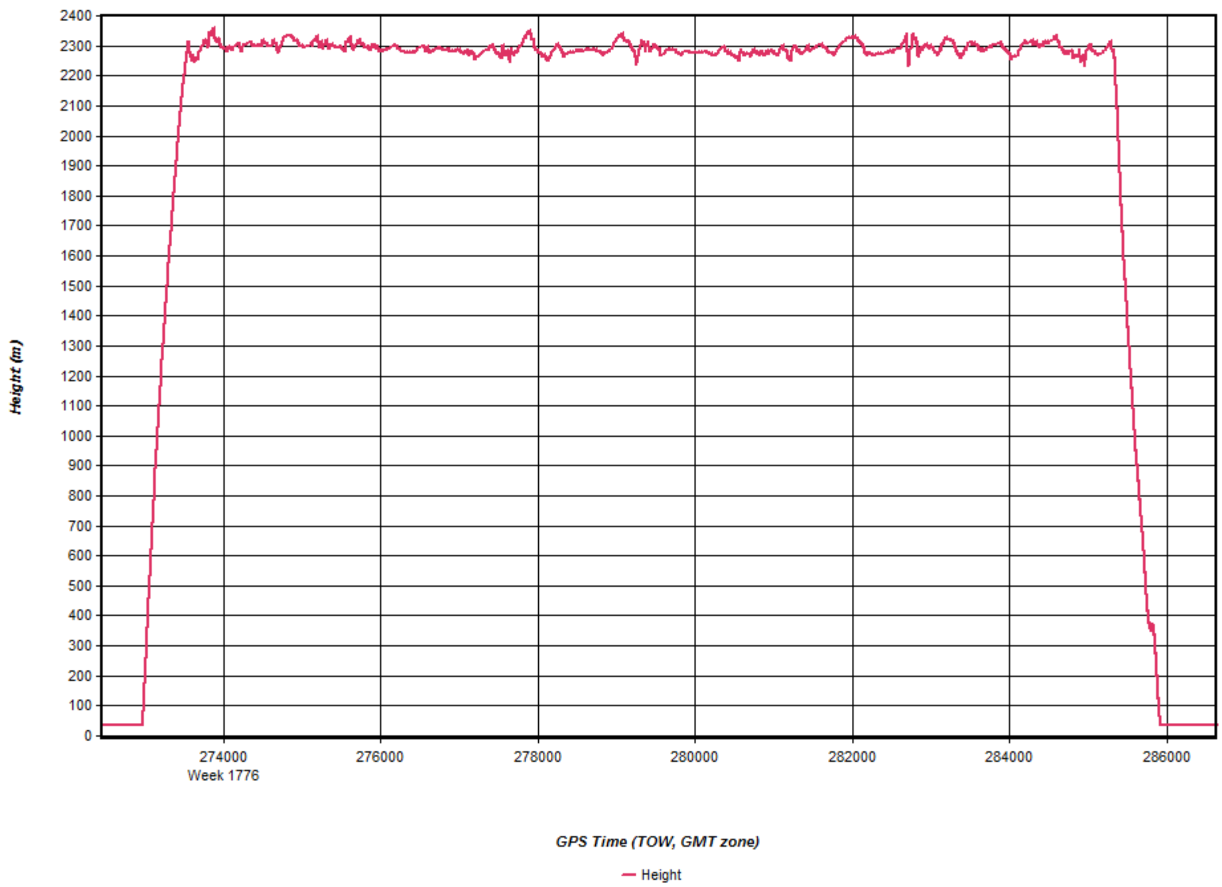

0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
Separation (m)
237000
Week 1776
238000
239000
240000
241000
242000
243000
244000
245000
246000
247000
248000
GPS Time (TOW, GMT zone)
East
North
Up

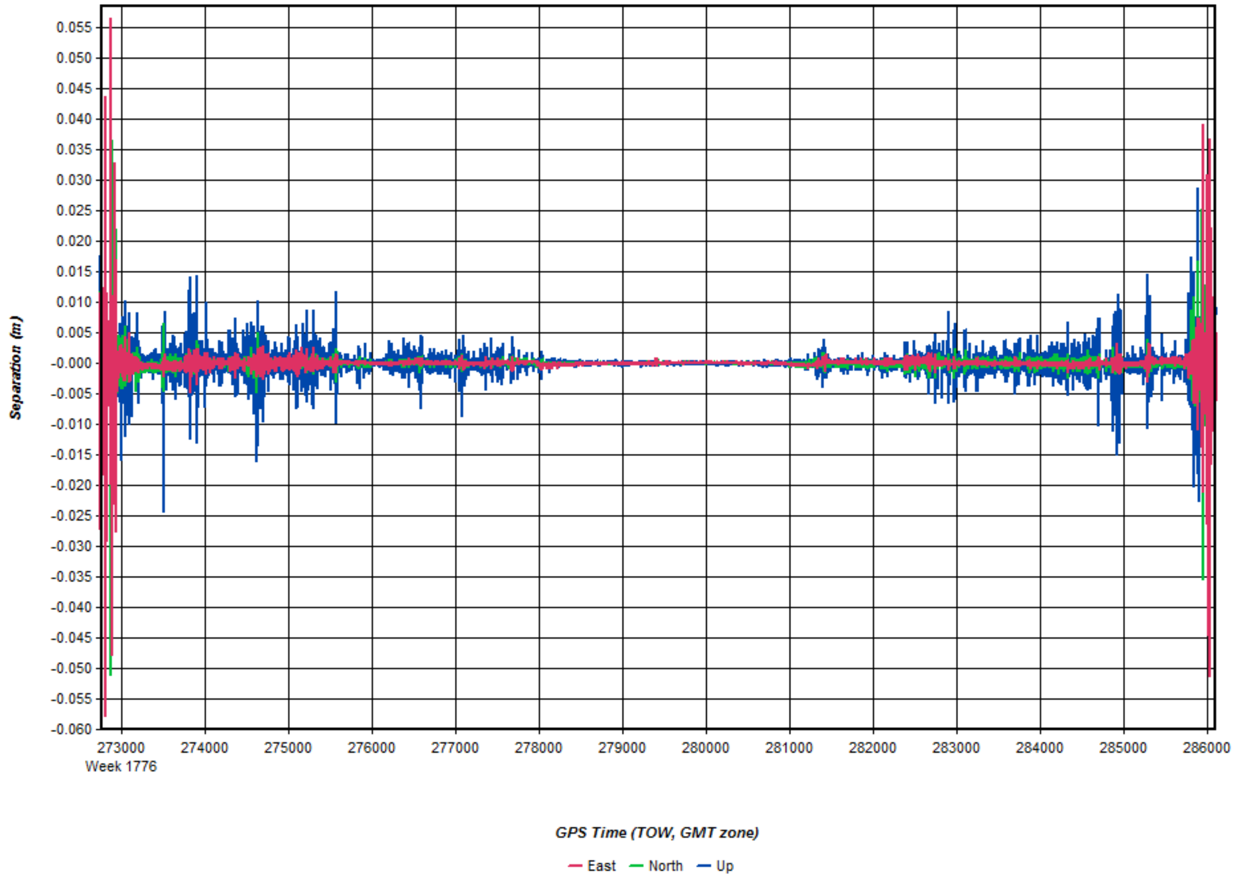

PDOP
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
236000
Week 1776
237000
238000
239000
240000
241000
242000
243000
244000
245000
246000
247000
248000
249000
GPS Time (TOW, GMT zone)
PDOP

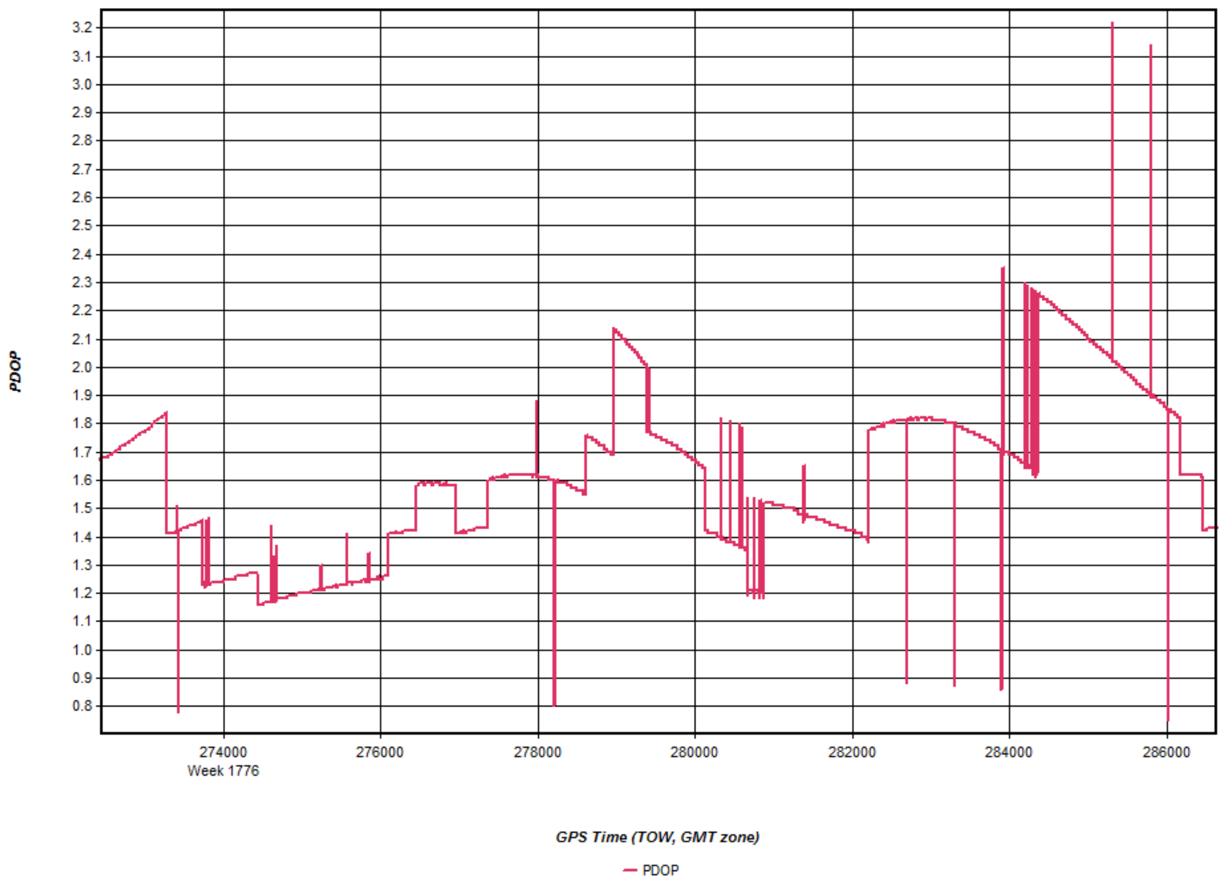
JD14021F02

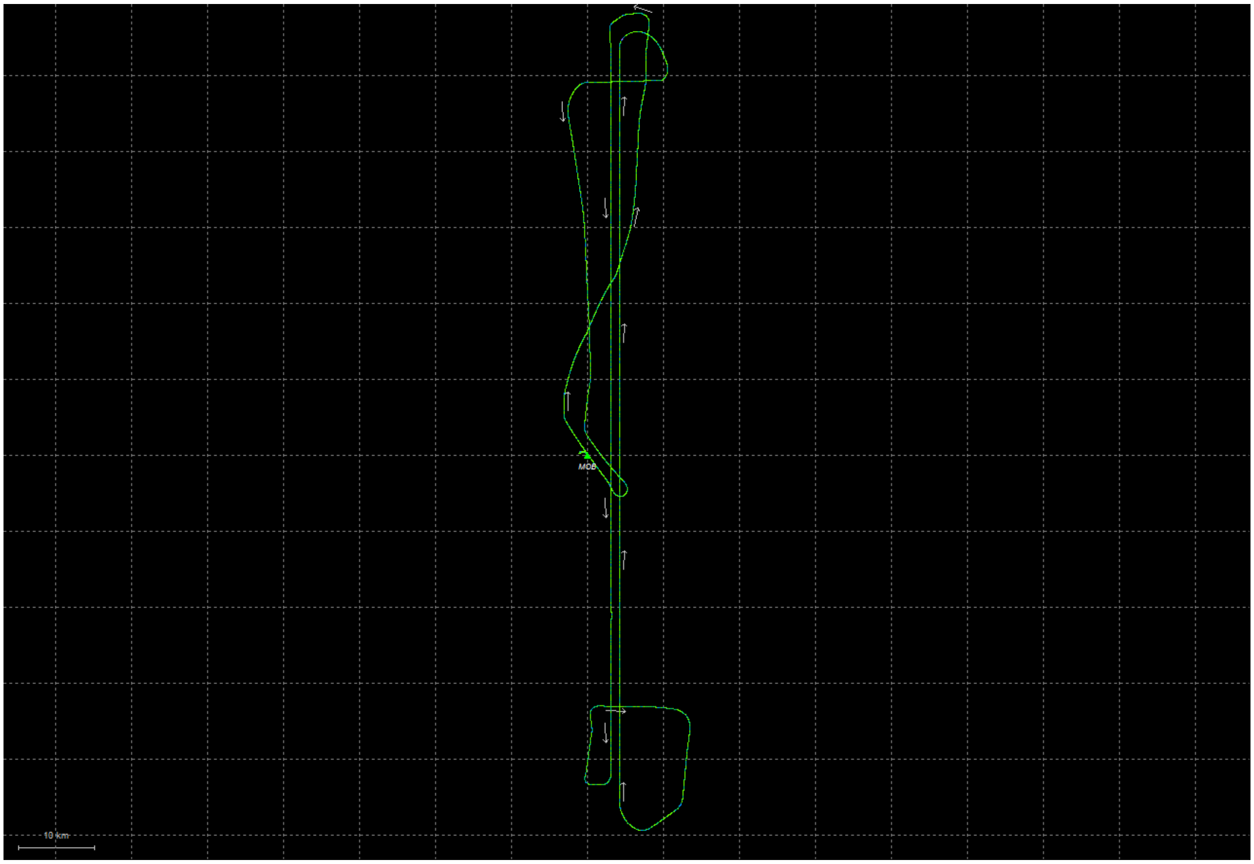

MOB
10 km

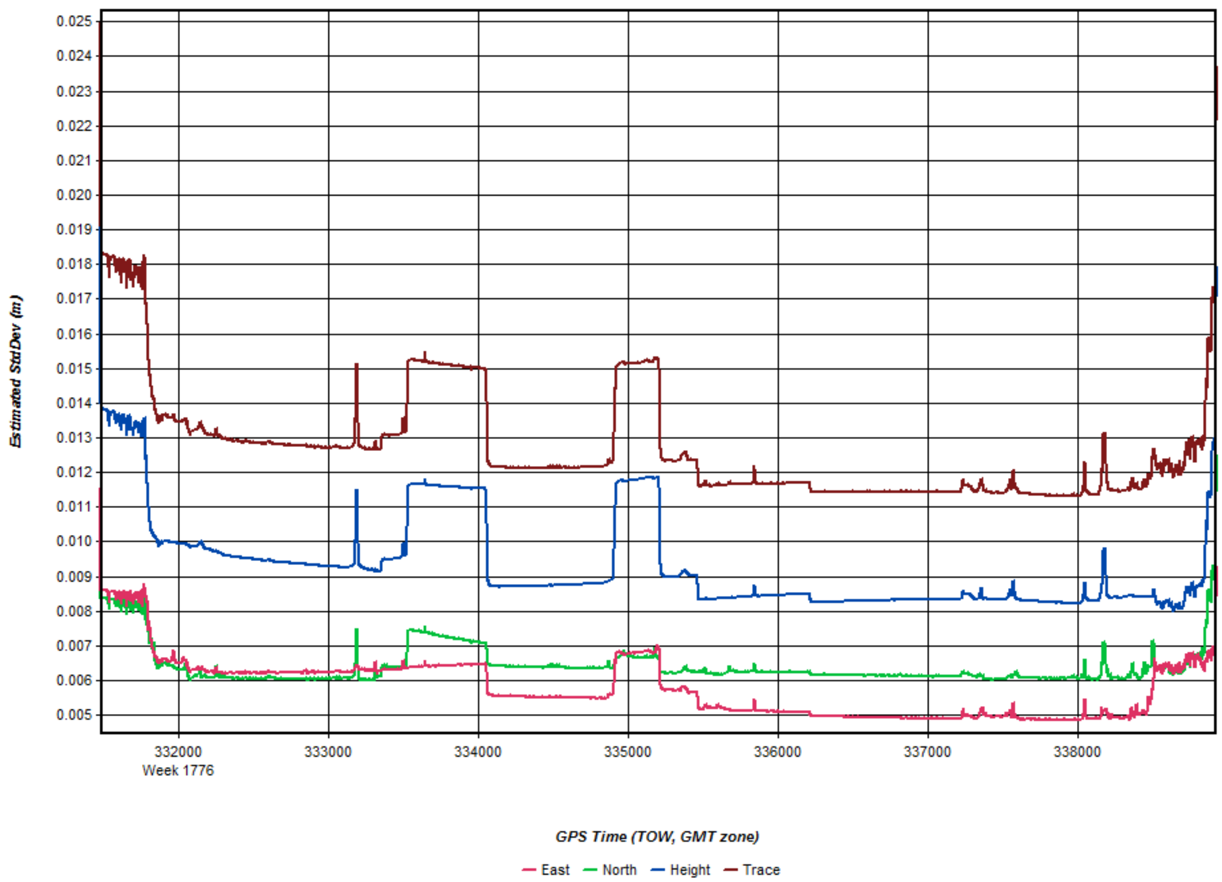

0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
Estimated StdDev (m)
274000
Week 1776
276000
278000
280000
282000
284000
286000
GPS Time (TOW, GMT zone)
East
North
Height
Trace

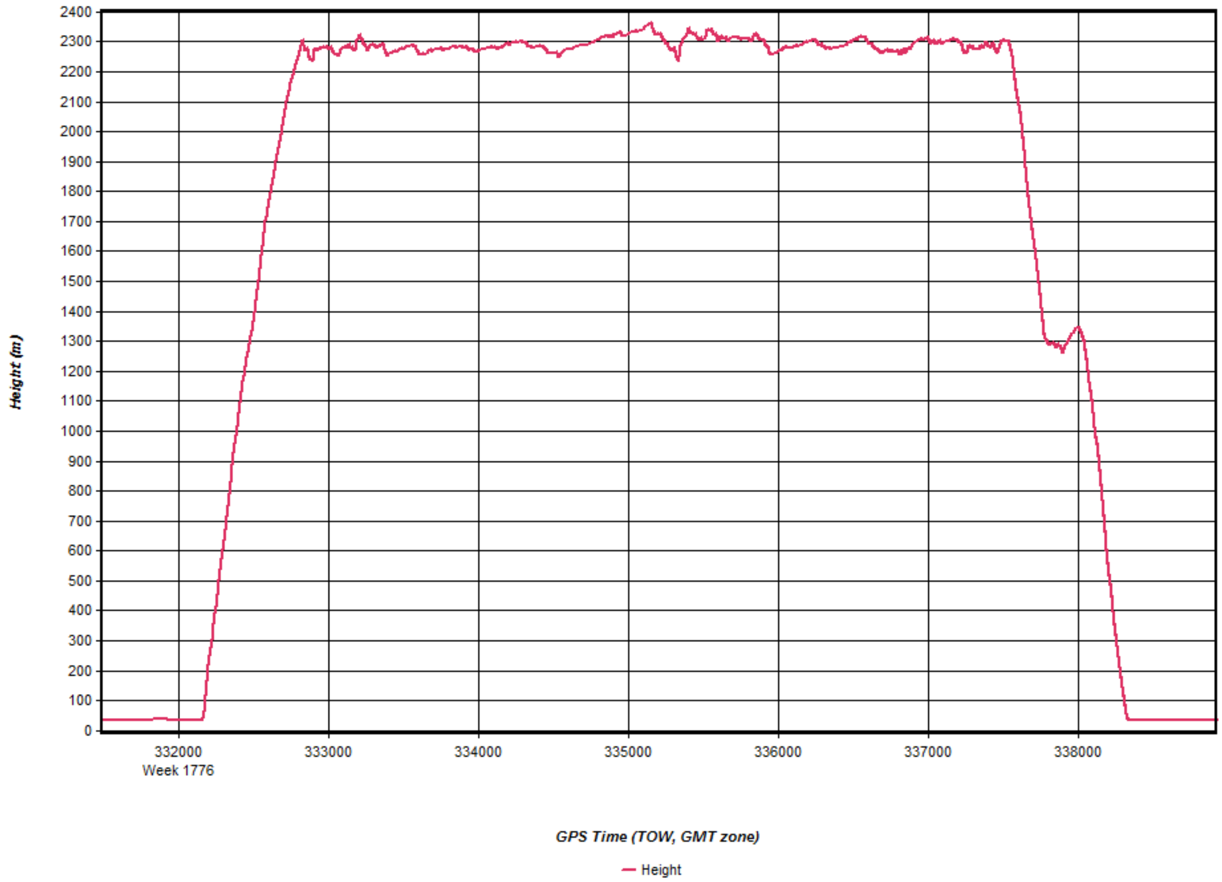

Height (m)
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
274000
Week 1776
276000
278000
280000
282000
284000
286000
GPS Time (TOW, GMT zone)
Height

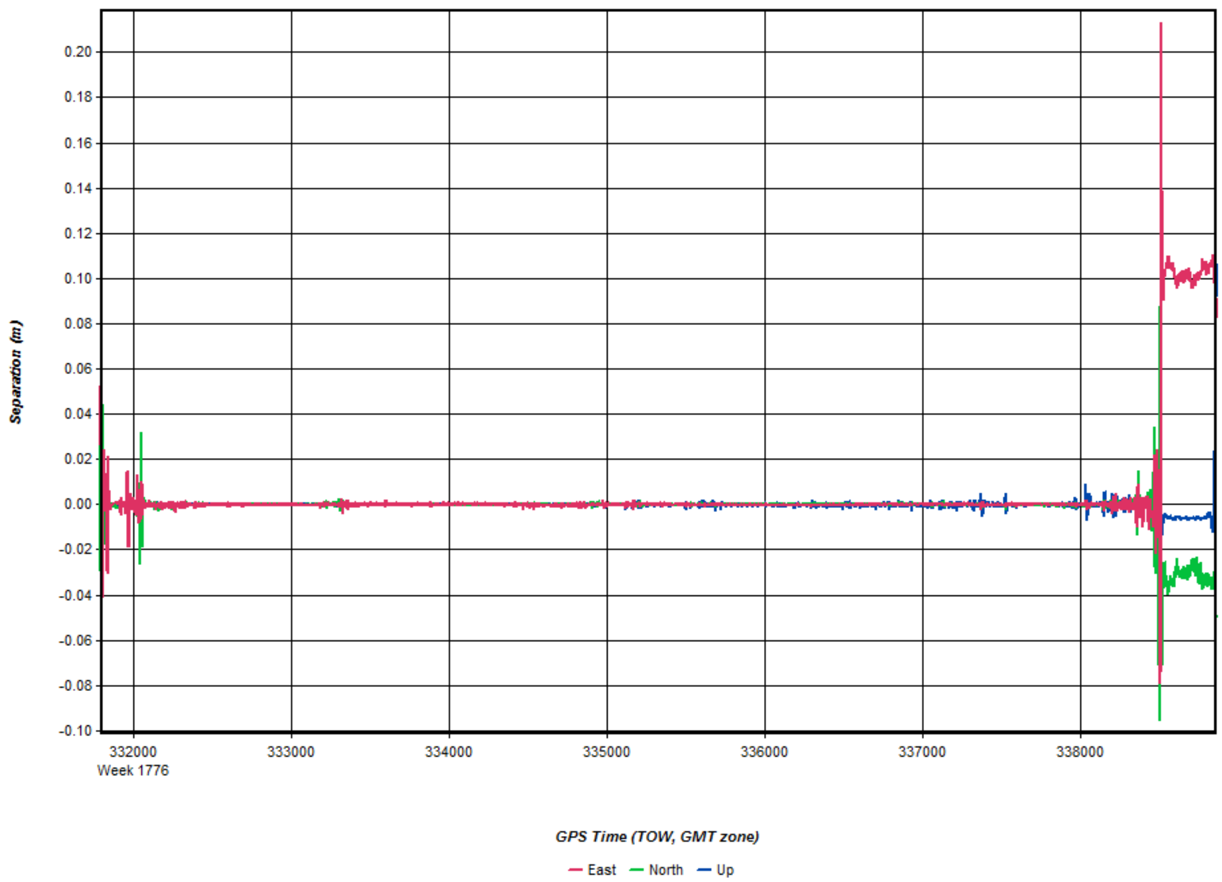

0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
-0.000
-0.005
-0.010
-0.015
-0.020
-0.025
-0.030
-0.035
-0.040
-0.045
-0.050
-0.055
-0.060
Separation (m)
273000
Week 1776
274000
275000
276000
277000
278000
279000
280000
281000
282000
283000
284000
285000
286000
GPS Time (TOW, GMT zone)
East
North
Up

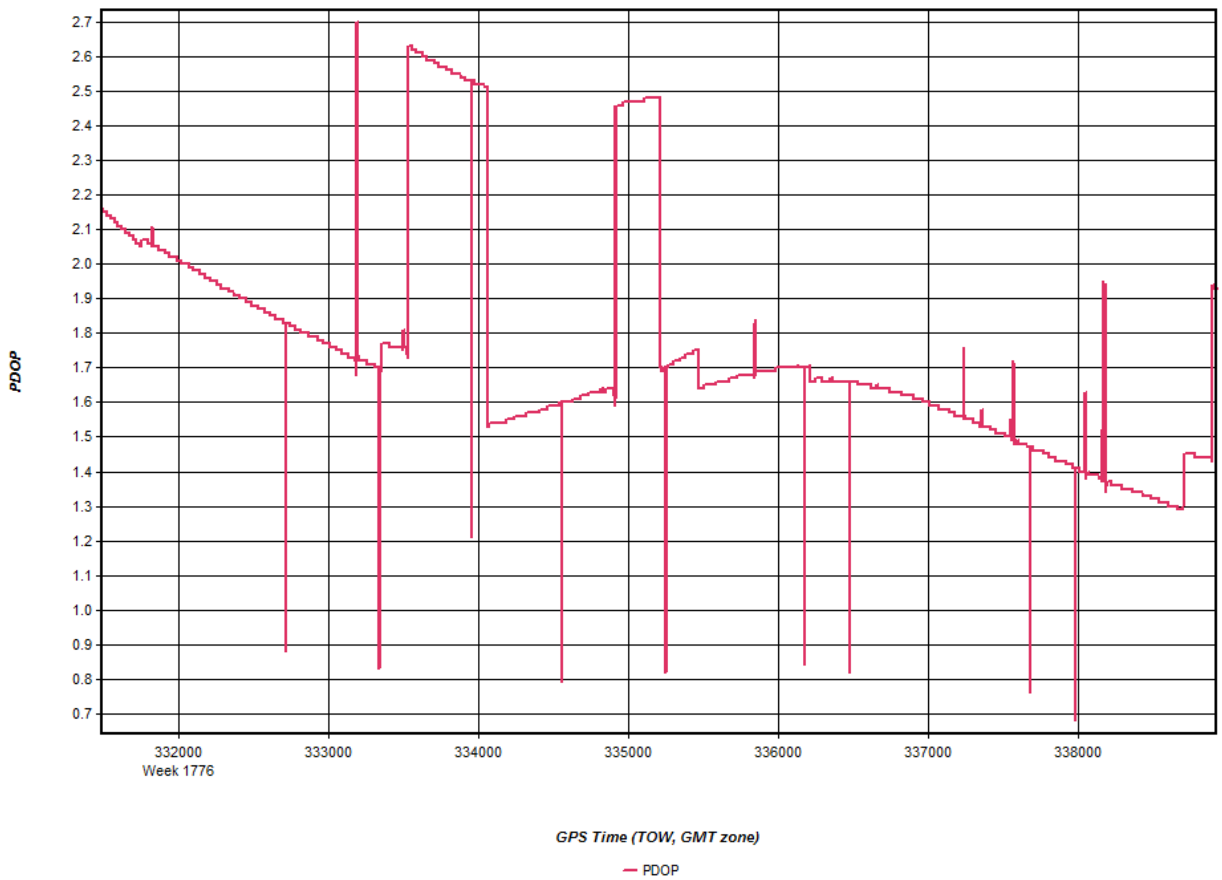

PDOP
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
274000
Week 1776
276000
278000
280000
282000
284000
286000
GPS Time (TOW, GMT zone)
PDOP


MOB
10 km


Estimated StdDev (m)
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
332000
Week 1776
333000
334000
335000
336000
337000
338000
GPS Time (TOW, GMT zone)
East
North
Height
Trace


Height (m)
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
332000
Week 1776
333000
334000
335000
336000
337000
338000
GPS Time (TOW, GMT zone)
Height


0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
Separation (m)
332000
Week 1776
333000
334000
335000
336000
337000
338000
GPS Time (TOW, GMT zone)
East
North
Up


PDOP
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
332000
Week 1776
333000
334000
335000
336000
337000
338000
GPS Time (TOW, GMT zone)
PDOP